POWER

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Coal

THE reverberations of the report of the Federal Coal Commission are dying away.

The average citizen has not the time, interest or inclination to read all of the facts recited or even the deductions therefrom. He simply knows that his coal supply is precarious and feels that he is paying too much for it when he does get any. The report tends to ratify his conviction, but does not very positively point out a remedy.

The bright and shining spot for him is its declaration that the production and distribution of coal are charged with public interest and should be regulated as other public utilities are.

There is no use in proving that respectable thieves conspire to rob the public by selling back and forth to each other unless you can put them in jail for it. People will partake of communion with them, eat their dinners and smoke their cigars and be flattered by their notice in direct proportion to the pile that they have made out of it.

The public will watch with more than ordinary interest to see what the Congress is going to do about it.

The attitude of those coherent interests which regard the preservation of their liberty to exploit the public as of more account than the rational control and administration of this basic national resource, is that of "Let us alone!" "Don't you know you're hurting business?" "Down with governmental interference!"

All sorts of efforts will be made to withhold the Congress from doing anything that can be seen and felt, anything with teeth in it; for inasmuch as it may do it unto coal, so may it do it unto other necessities of life.

F. R. Low

Powdered Coal Meets Load Variations in Blast-Furnace Gas Plant

IN A boiler installation in the Ensley Works of the Tennessee Coal, Iron & Railroad Co. powdered coal supplements blast-furnace gas to maintain uniform supply of steam. Outstanding features of the plant are the automatic control of the gas and air mixture and the feed of the powdered coal.

An installation of steam boilers having an aggregate of 50,000 sq.ft. of heating surface has been placed in operation recently by the Tennessee Coal, Iron & Railroad Co., at its Ensley Works, Birmingham, Ala., as an addition to its blast-furnace boiler plant, primarily for the purpose of meeting the peak-load requirements and maintaining a constant and uniform supply of steam to the various power plants and mills. These boilers, using surplus gas from six blast furnaces, form an additional unit to an existing boiler plant containing 240,000 sq.ft. of surface.

The new installation consists of a battery of six 8,340-sq.ft. boilers, built for 250-lb. steam pressure and equipped with superheaters designed to give 200 deg. superheat. Blast-furnace gas is used as fuel when available, and powdered coal is used as an additional fuel when gas is not available in sufficient quantities to meet the steam demands. Features of this installation are the methods employed of automatically controlling a relative mixture of gas and air for the gas burners and for supplying powdered coal as a supplementary fuel as required for maintaining a uniform pressure in the main steam line.

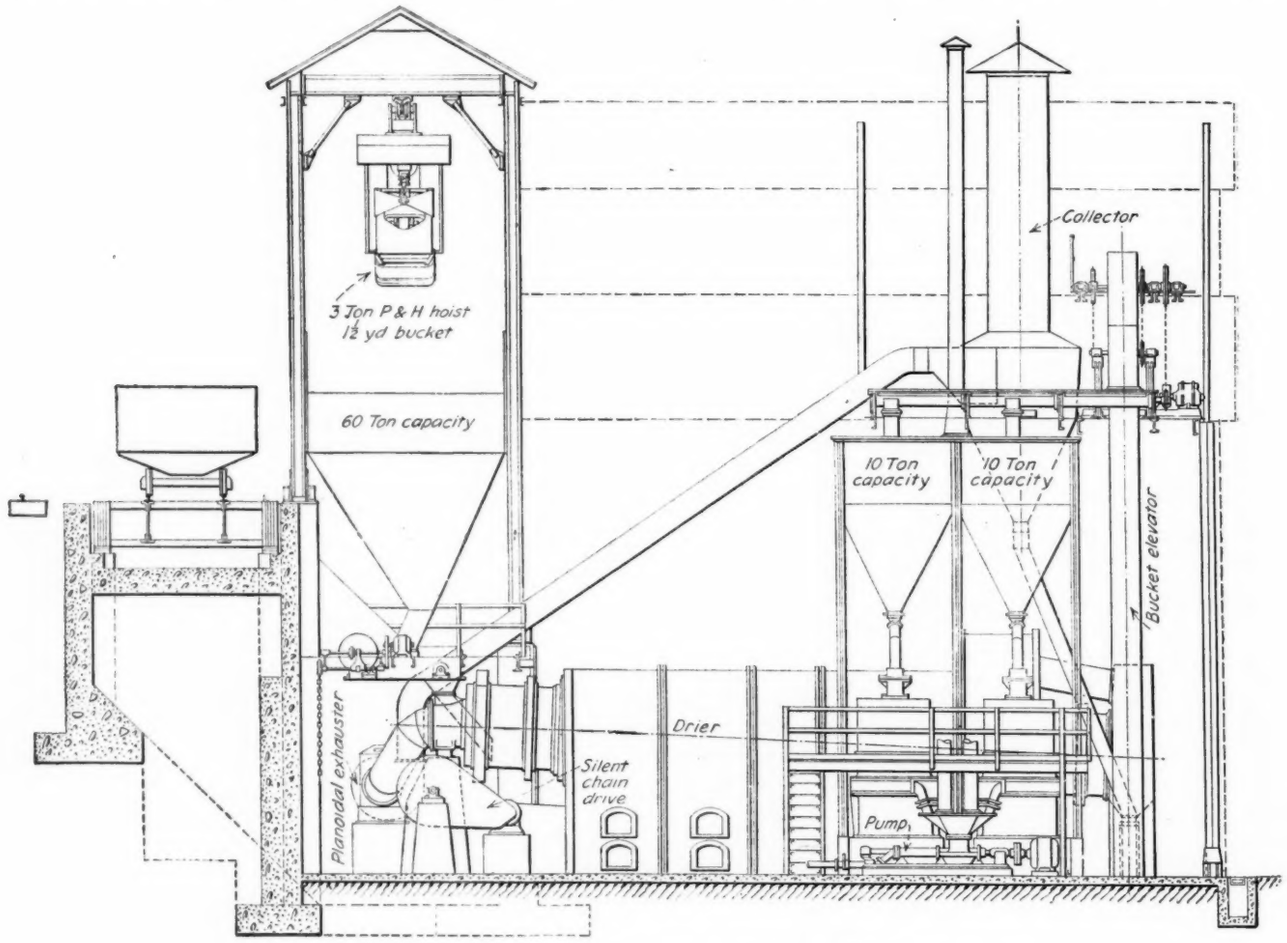


FIG. 1—SECTIONAL ELEVATION THROUGH COAL-PREPARATION PLANT

The object was to help overcome a problem usually experienced in blast-furnace boiler plants resulting from a fluctuating and frequently insufficient gas supply, aggravated by sudden and large steam demands. Previously, this condition was overcome partly by hand-firing coal on a number of the gas-fired boilers provided with plain grates for the purpose. This practice was not only inefficient but costly to operate, requiring a considerable force of laborers for firing and handling coal and ashes.

The coal-pulverizing plant is about 300 ft. northwest of the boiler plant and alongside the elevated approach

tracks to the furnace stock bins. This location was selected on account of the ideal condition afforded for dumping and storing the coal supply and of the isolated position, which reduces the fire hazard.

The coal used is either boiler coal, which is a middle product from coal washers preparing coal for byproduct coke ovens and carrying from 20 to 25 per cent ash and up to 10 per cent moisture, or high-ash coal screenings, either of which will average between 11,000 and 12,000 B.t.u. per lb. on a dry basis. This is all crushed to under one-inch size before being washed. Coal is delivered to the pulverizing plant on a high-level track over concrete trestle bins with a storage capacity of about 1,500 tons. The bottoms of the bins have a slope of 45 deg., causing the coal to shift to one side of the track and under a telpher runway equipped with a 3-ton hoist with a 1½-cu.yd. grab bucket. From here the coal is transferred to a 60-ton capacity steel bin over the charging end of a rotary drier.

This bin has a hopper bottom with a spout to a feeder box in which is operated a drag chain to feed the coal to a chute discharging into the drier. The feeding device is driven by a 5-hp. motor through a variable high-speed friction drive which can be adjusted from the ground floor. The coal drier, measuring 5.5x45 ft., is of the indirect-fired type with a rated capacity of 12 tons an hour, reducing moisture from 10 to about 1½ per cent. The drier is fired with byproduct coke-oven gas and is equipped with grates for burning coal in emergency. Draft is furnished by a 60-in. exhaust fan directly connected to a 15-hp. motor and discharging into an 8-ft. cyclone collector supported overhead between the roof trusses.

Collected coal dust recovered from the draft exhaust is discharged periodically by means of an automatic damper in a spout leading from the collector to the drier discharge chute. The dried coal is lifted by a vertical bucket elevator and discharged over a 24x18-in. magnetic separator for removing tramp iron and then passes through a 12-in. screw conveyor into either of two 10-ton capacity bins over the pulverizers. The coal is then spouted to two 46-in. screen-type pulverizers, each with a rated capacity of 5 tons an hour and driven by a 100-hp. motor through bevel-gear reduction.

A fire-wall partition separates the drying from the pulverizing equipment to reduce the possibility of a dust explosion. The plant is equipped also with a vacuum cleaning system, consisting of a 3-hp. motor-driven turbine with a suction-pipe system having 2-in. plug connections for detachable vacuum cleaners located in various places in the plant. Coal dust is collected into a 30-in. primary collector and an 18-in. secondary

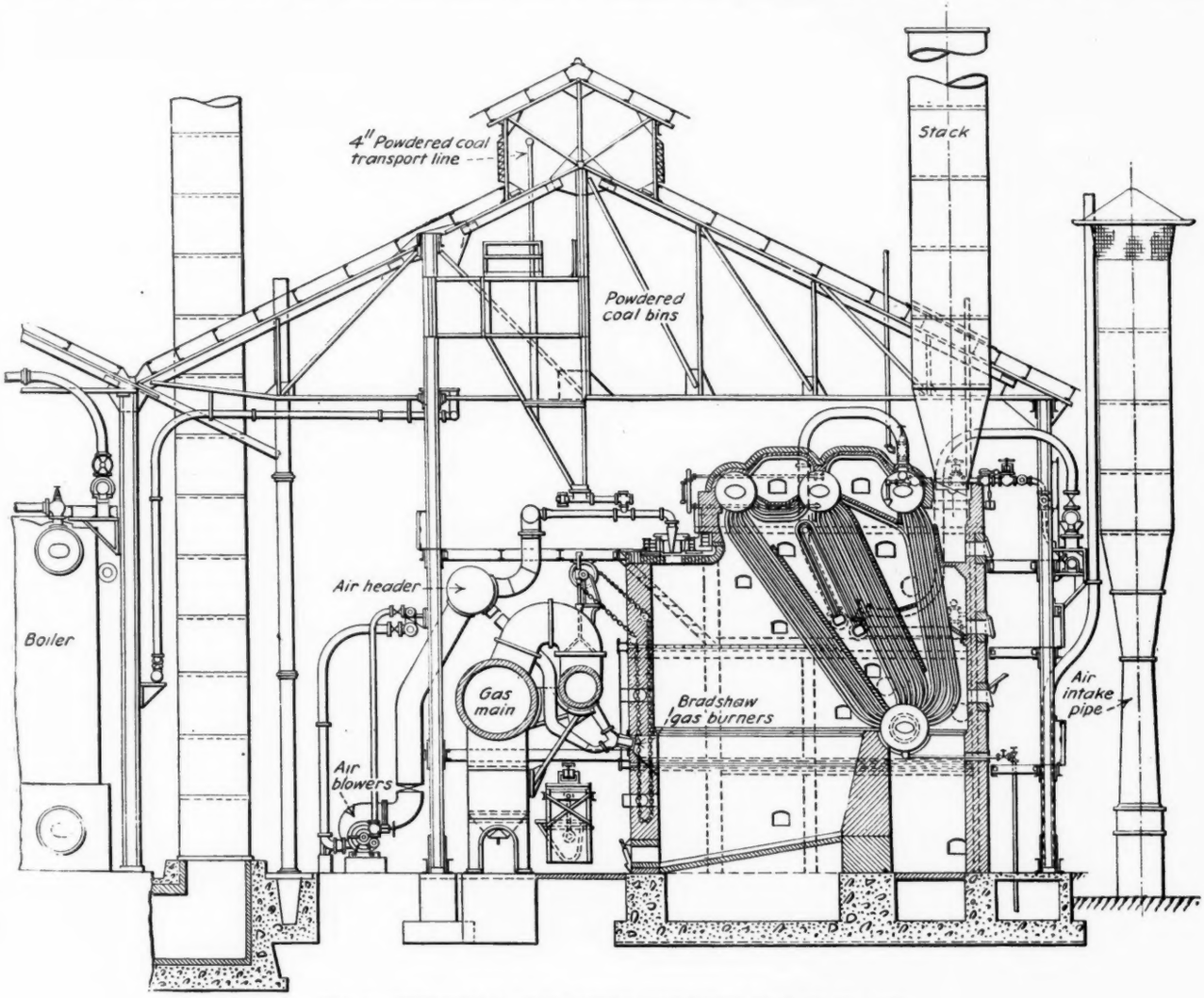


FIG. 2—SECTIONAL ELEVATION THROUGH BOILER PLANT

collector over the pulverizer bins to where the recovered dust is returned.

Fig. 1 is a side elevation showing the relative positions of the coal-storage bins, telpher runway and the drying and pulverizing equipment.

Transport System

From the two pulverizers the powdered coal passes into a 6-in. screw-type pulverized-material pump directly driven by a 25-hp. motor. This pump delivers the material through a 4-in. transport pipe over a maximum distance of about 650 ft. to bins suspended over each boiler. To facilitate the flow of the powdered coal through the transport line, compressed air at about 30-lb. pressure is injected into the coal through small nozzles in the pump in sufficient quantity to cause the coal to remain in an "expanded" condition until it is delivered into the boiler coal bins, where the air escapes through vent pipes as the coal settles into storage.

A small compressed-air line is placed alongside the transport line with ½-in. connections about every 20 or 30 ft. for the purpose only of blowing out the line in case of stoppage. During the period of several months that the transport line has been in operation, there has been no occasion requiring the use of these connections.

Powdered-Coal Burning Equipment

Since powdered coal is provided as an auxiliary fuel, it is not contemplated that it be used continuously to the extent of the capacity of the burners, which are designed to develop 200 per cent boiler rating. Each boiler has a storage bin of 20 tons capacity, which is sufficient for approximately twenty-four hours' supply at the average rate of operation, or about five hours' supply at the maximum rating of the burner, so that the operation of the pulverizing plant can be continuous until all the bins are filled, and then shut down.

With a capacity of 10 tons an hour the pulverizing plant operates on one turn a day to meet the average boiler requirements for 24 hours. The storage bins have automatic signal lights operated by small diaphragms inside the bins, which cause the lights to signal when the bins are empty and when full. Hand-operated indicators also are provided for gaging the contents of each bin. A 1,000-lb. capacity hopper scale is used for weighing tests of powdered coal as it is delivered from the transport pipe into the boiler bins.

Fig. 2 is a cross-section through the boiler plant, showing the relative layout of boilers, gas main, gas burners, powdered-coal bins, powdered-coal burners, air main and blowers, and the ash-handling crane. Five boilers are each equipped with Fuller-Lehigh vertical powdered-coal burners with individual screw feeders driven by 1-hp. variable-speed motors. Powdered coal is fed from the 20-ton bins into mixing chambers, each supplied by a 6-in. air pipe, and then passes on to the burners.

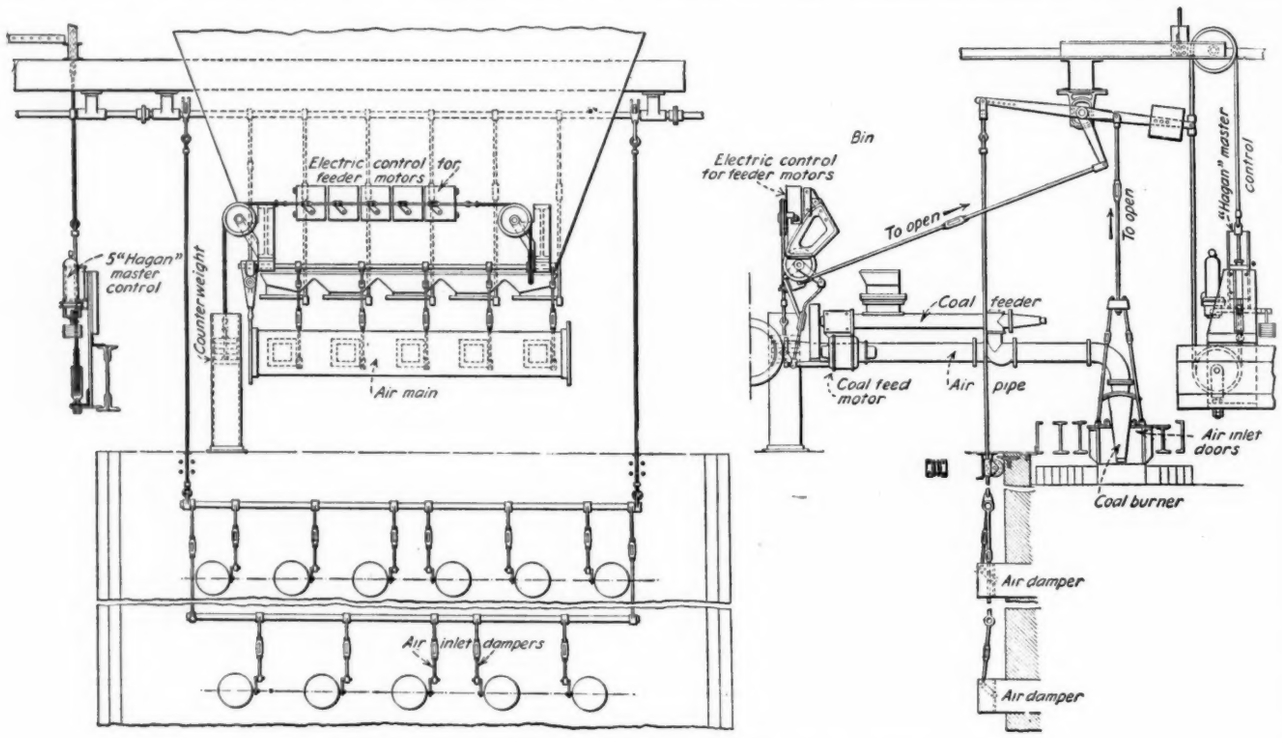


FIG. 3—CONTROL FOR COAL FEED AND AIR DAMPERS

The burners enter the top of the combustion chamber through a flat, suspended arch. Upon entering the burners, the coal carries with it about 40 per cent of the air required for its combustion as a carrying medium, the remainder of the air being admitted through eleven 12-in. circular openings with dampers in the front wall and through air-inlet doors on the burners. Exceptionally good results have been obtained from the special design of the combustion chamber, which is unusually large, having a volume of 0.57 cu.ft. per square foot of boiler-heating surface. The boilers are set so as to give a height of about 25 ft. in the combustion chamber, to facilitate complete combustion of the powdered coal and to reduce the amount of ash deposit.

Powdered-coal feed drives, air supply to the burners and the air-inlet dampers for the entire five boilers are

controlled automatically through a system of levers by a master control shaft placed horizontally above the boilers. This shaft is operated by the movement of a 5-in. Hagan master regulator actuated by variation in pressure in the main steam header. The automatic rigging for each boiler can be detached and operated by hand if necessary. Fig. 3 shows the arrangement of the automatic mechanical control rigging for the air supply and air-inlet dampers and the automatic electric control for the feeder drives. Fig. 4 is a side elevation of the powdered-coal burners and connections as applied to five boilers.

The sixth boiler is equipped with four Raymond low-pressure powdered-coal burners. The feeding device for these burners is similar to those installed on the other five boilers, excepting that all four feeders are driven by one 7½-hp. motor with a variable-speed transmission set which is interlocked with the air-supply valves. About 50 per cent of the air required for combustion enters with the powdered coal, the remainder being admitted through the eleven 12-in. circular openings with dampers in the front wall, as previously described for the burners. The air-inlet dampers are connected to a shaft and operated by a hand lever. No automatic control was installed in connection with this unit. Fig. 5 is a side elevation of the powdered-coal burners, feeders, etc., as applied to this boiler.

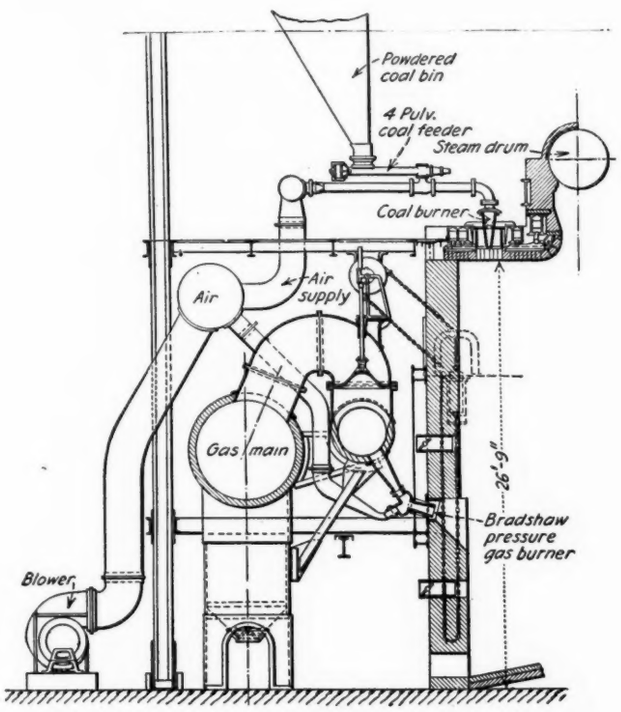


FIG. 4—GAS AND POWDERED COAL BURNERS FOR FIVE BOILERS

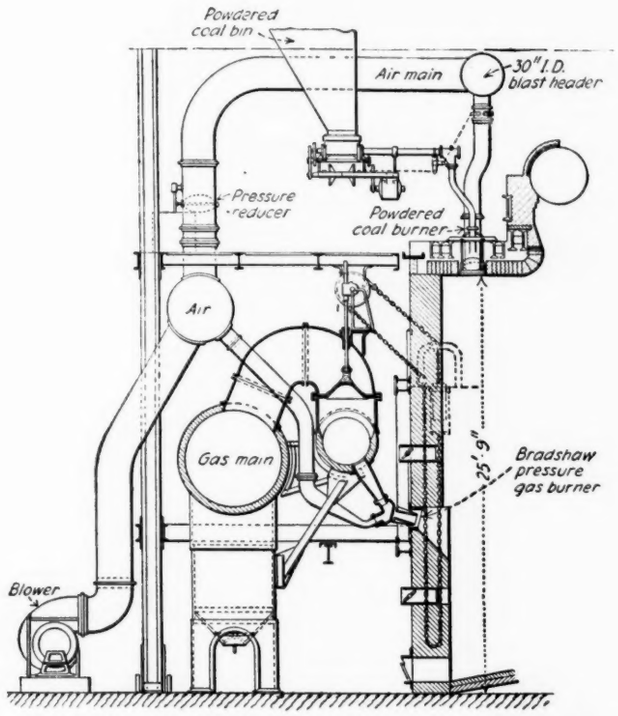


FIG. 5—POWDERED COAL AND GAS EQUIPMENT OF SIXTH BOILER

GAS-BURNING EQUIPMENT

Each of the six boilers has two pressure-type blast-furnace gas burners, with a capacity to generate 200 per cent boiler rating. These burners, as will be seen in Fig. 2, enter the combustion chamber through the lower front wall. A proportional supply of gas and air to the burners is maintained, regardless of the gas pressure and the amount of gas being consumed, by a relative operation of dampers in the gas and air connections of the burner body. This relative operation, after the proper adjustment is made, is controlled automatically to suit the fluctuating gas pressure, by an operating rigging similar to that just described for controlling the powdered-coal burners. It consists of a lever rigging connected to the dampers and operated by a master control shaft serving the entire six boilers.

The master control shaft is rotated by the movement of a 5-in. special combustion regulator actuated by the pressure in the blast-furnace gas supply main.

An air pressure of 6 in. of water column is maintained in the supply line to the gas burners and powdered-coal burners by a 2-in. blowing-engine regulator which governs the steam turbines driving the fans. Air supply to the powdered-coal burners on boiler No. 6 is reduced to 1 in. of water pressure by a pressure reducer.

CO_2 recorders, indicating steam-flow meters and draft gages are installed on each boiler, and an integrating steam-flow meter is installed on the main steam line leading from the boilers. A gas-flow meter is located in the blast-furnace gas supply main, and coal meters are provided in the dried-coal chutes leading to the pulverizers, so that it is possible to make an approximate check of the efficiency of the plant daily.

Ashes and blast-furnace gas flue dust are removed when a boiler is down and are disposed of by a traveling telpher equipped for handling a 65-cu.ft. ash pan, which runs on an overhead I-beam track directly in front of the boilers and extending through the boiler house to the original coal-and-ash-handling system of the main boiler plant.

The operation of this plant is claimed to have met all expectations and has demonstrated that this method of supplementing blast-furnace gas is entirely satisfactory.

Acknowledgment is made to George G. Crawford, president of the Tennessee Coal, Iron & Railroad Co., for his co-operation in supplying the material for this article.

Minimum Number of Hydro-Electric Units To Have in Service

Factors That Determine the Number of Machines To Have in Service—How Loading of Machines Affects Efficiency of the Plant—Methods of Supplying Wattless Current to the System

By RALPH BROWN*

CONCERNING the minimum number of generators that should be operated without risk to service, at first thought it might be said that there should always be sufficient generating capacity connected to the bus to permit of instantly cutting out the largest unit, but actual experience has demonstrated that hydro-electric generating units are so reliable that the possibility of a failure occurring without warning is extremely remote, and this is particularly true where inspections are regularly made. It appears, then, that the minimum number of generating units that should be kept in operation is the number required to supply sufficient short-circuit current to insure positive relay action and to maintain normal speed regulation. This question is influenced by the time required to start and synchronize a generator, since fewer generators might be safely operated where a unit could be loaded from standstill in two minutes than if five minutes were required. There is no advantage in operating an unnecessarily large number of generators, and to avoid wear and tear of generators and station auxiliaries the load per unit should be maintained above 50 per cent of normal, except for relatively short periods.

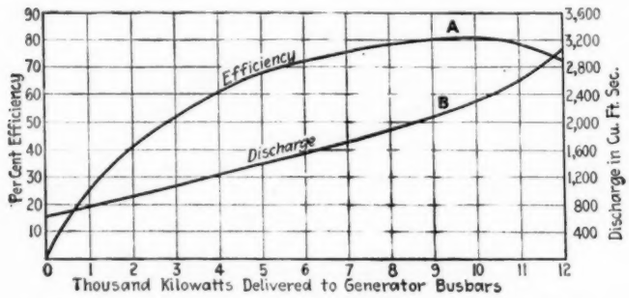


FIG. 1—POWER-EFFICIENCY-DISCHARGE CURVES FOR REACTION-TURBINE GENERATING UNIT

Under certain conditions generating units are operated at zero, or very light load for stand-by service, power-factor correction, or to insure relay operation; and where such operation is followed, the greatest water economy will result if the nozzles or vanes are tightly closed, the generator operating as a synchronous motor. If, as is sometimes done to avoid negative readings, enough water is applied to the runner to maintain a zero rather than a reversed reading on the wattmeter, due to the extremely low efficiency when generator losses only are supplied in this manner, a very large amount of water would be required. Referring to Fig. 1, about 620 cu.-ft.-sec. would be discharged if the generator drew no power from the bus, whereas this amount of water would produce 2,200 kw. from a similar unit operated at an efficiency of 68 per cent, or that corresponding to a load of 5,000 kw. Since the energy required to operate this unit as a motor, with the turbine vanes tightly closed and air admitted to the draft tube to break the vacuum, thus allowing the runner to revolve free of the braking effect of the water, is approximately 300 kw., it can be seen that a decided saving would be obtained by operating the unit as a synchronous motor, other units operating at efficient loads supplying the power required to maintain rotation.

Reference to Fig. 2 will show that the efficiency of a power transformer is high even when lightly loaded. The three-phase transformer to which this curve applies has a core loss of 63 kw., which remains practically constant from no load to full load, and a copper loss, at full load, unity power factor, of 60 kw., which is proportional to the square of the current. Since the power factor for the core loss of this 8,000-kva. transformer is approximately 10 per cent, at no load about 630 kva. would be required for excitation, indicating the objection to operating transformers at zero or very low loads, when the system power factor is to be maintained at the highest possible value.

Even including the energy available from the cooling water when a transformer is cut out, no appreciable saving results from switching a transformer out unless its load is very light, but good operating practice requires that the load on such equipment be maintained between the limits of 50 and 100 per cent of normal,

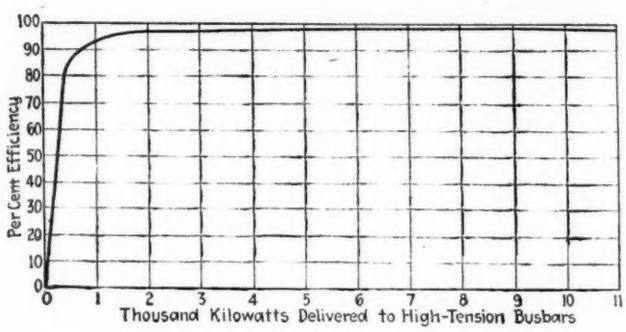


FIG. 2—POWER-EFFICIENCY CURVE FOR LARGE 8,000-KVA. TRANSFORMER

depending on the temperature of the winding. A safe temperature range is from 4 deg. C. above room temperature during cold weather, to avoid condensation from the cooling coils, to a maximum of 60 deg., these temperatures applying to the coil.

Referring to the table, the total transformer loss would be increased but 92 kw. (312-246) if two rather than four 8,000-kva. transformers were delivering 16,000

*The Western Power Company.

kw. at unity power factor, and at 3 mills per kilowatt-hour the possible saving would amount to but 30 cents an hour. Where rigid economy of water must be practiced, however, the number of transformers in operation should be such that the transformer losses will be minimum, and tables or curves, based on the core and copper losses of individual transformers, indicating the economical number of transformers to operate for all possible station outputs, should be provided for the guidance of the operators.

When maximum output is required, the head should be maintained as high as possible, all generating units should be operated wide open, and since the problem is to make available for sale the maximum number of kilowatt-hours, care should be taken to reduce to a minimum the amount of alternating-current energy

TRANSFORMER LOSSES FOR DIFFERENT LOADINGS

Kilowatts Delivered To H. T. Bus	Loss in kilowatts when number of transformers indicated below are operated. 1	2	3	4	Economical Number of Transformers
32,000	...	...	...	492	4
28,000	...	...	435	436	3
22,000	...	...	369	387	3
20,000	...	...	315	346	3
16,000	...	246	270	312	2
12,000	...	194	234	286	2
8,000	123	156	214	268	1

required for station power and lighting. Hence, where station auxiliaries, such as pumps, are driven by alternating-current and direct-current motors, as much direct-current energy as possible should be used, provided it is generated by waterwheel-driven exciters, and energy for excitation should be obtained from turbine-driven exciters rather than from motor-generator sets requiring alternating-current power for their operation. Heating circuits should be transferred to the direct-current station service bus, and as many auxiliaries as possible operated only during off peak hours.

When economical output operation becomes necessary, the consumption of energy for station lighting and power should be reduced to the minimum by operating the most efficient auxiliaries and only fully lighting those parts of the station where men are at work. Obviously, the efficiencies of station auxiliaries can be determined only by test, and it is advisable that such tests be made on the more important equipment, such as lubricating and governor oil pumps. The installation of watt-hour meters on the motors of the principal auxiliaries will enable a constant check to be kept on individual performances, and it is to be recommended where the energy used for station service constitutes an important item.

If an excessive amount of reactive, or wattless, current must be supplied by the generators in a hydroelectric plant, not only are the transmission-line losses increased to an objectionable extent, but the higher voltage required causes increased iron losses in the generators and transformers and demands an increased amount of energy for excitation purposes. Especially during periods of maximum-output operation, unless the generators are liberally rated, it may be impossible to operate all the units wide open continuously when the station power factor is less than 85 or 90 per cent, hence it is particularly necessary to distribute the reactive current properly at this time.

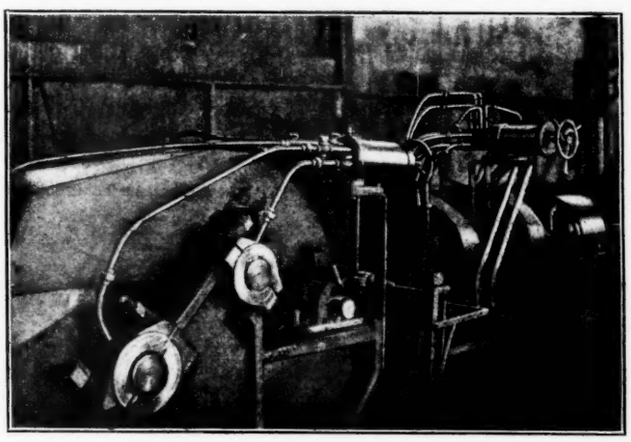
While the highest transmission efficiency is obtained if correction for low power factor is made at the point where it originates, it is generally not feasible to do this, but considerable reactive current can usually be carried on connected steam plants or on synchronous motors located in substations. Reactive current should be metered, which can be done on three-phase systems by connecting a polyphase wattmeter to read the wattless component, the kilovolt-amperes being computed from the wattless component meter and wattmeter readings.

While not the most efficient method, the most practical one is to operate generators of approximately the same rating at equal loads and power factors, but if there is some disparity in the ratings, the generators tending to overheat should be operated by increasing the kilovolt-ampere loads on the larger and cooler machines. This method of distributing the reactive current is the most inefficient one, but is justified when it becomes necessary to relieve a hot generator without reducing its kilowatt load, for the increased copper losses will generally be less than the loss resulting from decreased output if the generator heating is not relieved in this manner.

New Keystone Lubricator

The illustration herewith shows the application of a new type of lubricator that has been developed especially for supplying lubricant to bearings that are difficult of access.

The barrel of the lubricator is fastened to the machine or in some convenient position, and a connection is made to each bearing by means of pipe or flexible metallic tubing. By using a rubber hose connection from the ends of rigid leads, it is possible to lubricate moving bearings on pumps and other eccentric motions.



SEVERAL BEARINGS ARE SUPPLIED FROM ONE LUBRICATOR

Where it is desired to lubricate a considerable number of bearings from one lubricator, a manifold with the required number of outlets is attached to the barrel and the connections are led from this to the bearings. The manifold is of aluminum construction and each outlet is fitted with a brass valve.

The purpose of a valve in each is to provide a means of regulating the amount of lubricant fed to each bearing, or if desired one bearing can be supplied at a time. A gage is fitted to the barrel below the handwheel, to show how much lubricant is being used.

The lubricator is made in three standard sizes—1-lb., 4-lb. and 8-lb. capacity—and these are normally fitted with manifolds having 11, 15 and 21 outlets respectively. The lubricator is a product of the Keystone Lubricating Co., Philadelphia, Pa.

Checking the Performance of a Refrigerating Plant

By G. GROW

IN THE majority of refrigerating plants the engineers have no way of checking the performance of the plant beyond merely noting in the log sheet the suction and discharge pressures. In fact, when cold storage and not ice is the plant's output, it is impossible even to check output against the coal consumption or against the meter reading in an electrically-driven plant. The engineer realizes, often too vaguely, that he should carry the suction pressure as high as is possible

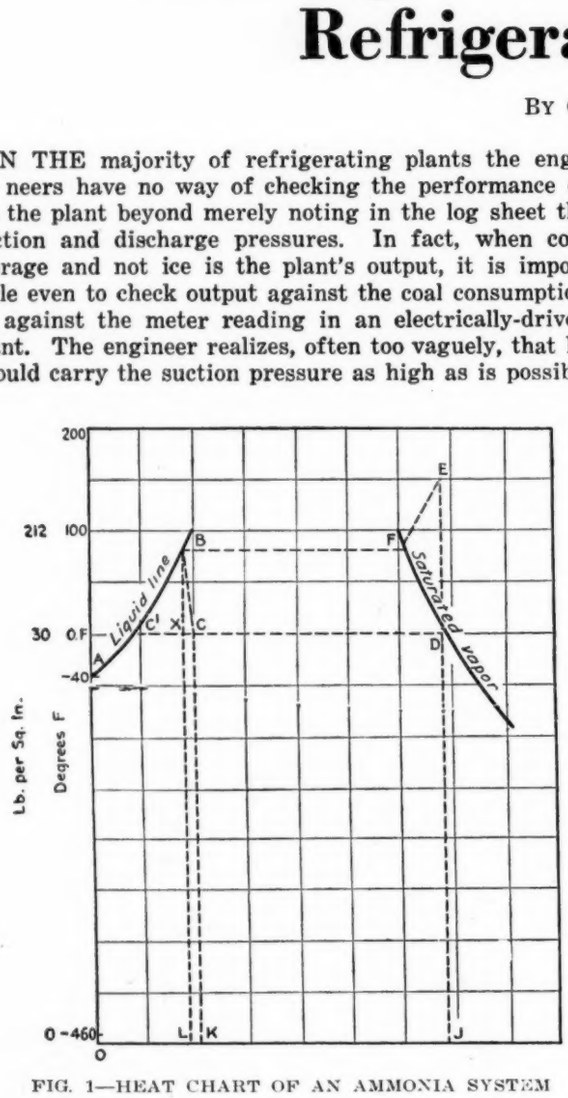


FIG. 1—HEAT CHART OF AN AMMONIA SYSTEM

in view of the requisite cold-storage temperature; likewise, that the condensing or head pressure should be kept as low as the available water supply permits is understood. But the actual comparison of results obtained with those possible is seldom made; in fact, few plant managers have the necessary data by which the comparison can be made.

Using Heat Chart to Check Results

A heat chart can be used in checking results, and after once grasping the procedure, an engineer should be able to make a check each time hourly readings of gages and thermometers are made. Measuring the charts of area would give definite value to the plant's performance, but this is unnecessary as a visual comparison with the standard for the existing suction and discharge pressures is sufficient to show whether the plant is functioning improperly.

The heat chart or, as it is familiarly called, the temperature-entropy diagram is shown in Fig. 1. In this chart the amount of heat in a pound of ammonia at, say, 80 deg. F. above the heat in it at —40 deg. is represented by the area *ABLO*. The condensing pressure of ammonia at 80 deg. F. is 153.1 lb. absolute, or 138.4 lb. gage. Assuming that the liquid at this pressure is passed through a reducing valve into the coils where the pressure is, say, 15 lb. gage, or 30 lb. absolute, the same amount of heat is in the ammonia leaving the valve that it had before reaching the valve. We can draw a line *BC* so that at *C*, when the pressure is 15 lb. gage, the area *AC'CKO* is the same as *ABLO*. Incidentally, it will be seen that part of the ammonia is vaporized in going through the valve in the ratio of *C'C* to *C'D*. The ammonia vaporizes in the coils and, when it becomes all vapor at *D* has picked up an amount of heat proportional to *CDJK*.

If the ammonia vapor reaches the compressor in a state where all the liquid is just vaporized, it is said to be in a "dry saturated condition." In being compressed in the compressor cylinder, heat equal to the work done on the vapor is added and, when discharged from the compressor, has had heat added to it proportional to the area *DEFBX* and will have a temperature indicated by *E*, being superheated, and a pressure indicated by *F*. If during compression some of the heat in the gas is lost to the cylinder walls, the line *DE* will not be vertical, which indicates adiabatic compression, but will slope to the left as indicated by the full lines from *D* to *E'* in Fig. 2. The temperature at *E'* is lower than at *E*. Little cooling can occur in a high-speed, ingle-stage compressor, and the line will seldom slope toward *E* to any extent. In slow-speed machines such a

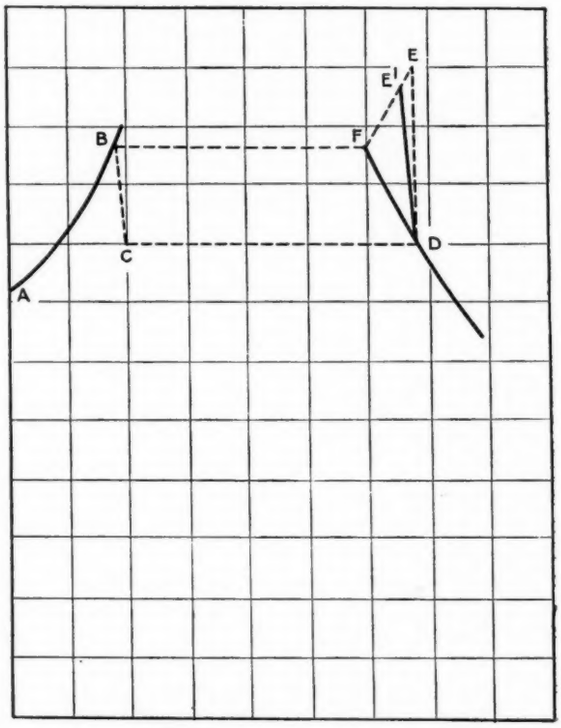


FIG. 2—EFFECT OF COMPRESSOR COOLING

slope does exist. On the other hand, if heat is picked up by the gas from the cylinder walls, the line will slope to the right as at *DE″*, in Fig. 3 and the temperature at *E″* will be higher than if the compression had been adiabatic as indicated by *DE*.

The hot vapor leaving the compressor at a temperature indicated by *E* has its superheat removed in the condenser until the temperature drops to *F*. Further cooling in the condenser causes the vapor to lose its heat of vaporization and, still keeping the pressure indicated by *F*, liquefies and is again back in the state represented by the point *B* and has only the heat of the liquid which is proportional to *ABLO* in Fig. 1.

Best Cycle for Single-Stage System

The cycle indicated in Fig. 1 is the best that is possible for a single-stage system with the stated suction and condenser pressures. The amount the actual operation differs from a standard such as the one indicated determines the relative performance of the plant. The work of compression is proportional to the area *BCDEF*, and if this area is decreased the plant's performance is improved. The coil temperature is determined by the amount of heat to be received from the cold-storage room or the ice tank and by the number of cubic feet of coil surface. In any plant, assuming a constant load, the number of coils is fixed and with a constant amount of ammonia circulated the temperature difference between the ammonia and the cold-storage is out of the engineer's control. If the coils are fed heavily enough to cause the ammonia to leave the coils in a dry-saturated condition, the engineer cannot change the position of the suction pressure line on the chart.

The head pressure depends on the amount of cooling water as well as the number of condenser stands, but the amount of water is the factor that is more or less under control. By increasing the supply, it is often possible to reduce the head pressure and consequently the work area. Foreign gases, by adding their pressures to that of the ammonia vapor corresponding to the condensing temperature, often keep the head pressure high; this can be lowered by purging. If a thermometer is placed in the condenser exit line, the ammonia temperature is immediately ascertained, and if the pressure indicated by the condenser gage does not correspond with the pressure shown on the chart Fig. 4, opposite the head temperature, he may be certain foreign gases are present. The ammonia liquid temperature should be within eight to ten degrees of the cooling-water temperature.

It has been indicated that the ammonia vapor should come to the compressor suction dry saturated. If the ammonia picks up more heat than is needed to make it dry saturated, it shows a temperature above that corresponding to the suction pressure. As example, if the suction pressure is 30 lb. absolute, the suction vapor temperature should be 0 deg. F. Suppose that the thermometer in the compressor suction line shows a temperature of 20 deg. F. This is a proof that the gas is superheated 20 deg., and if the thermometer at the evaporator coil outlet shows 0 deg., superheat has been picked up along the suction line and does no good. In fact, it increases the work of the compressor for, as shown in Fig. 4, the vapor entering the compressor is in the state represented by *D′*, having 20 deg. superheat. Now, as will be observed by the chart, when dry saturated a pound of ammonia vapor at 0 deg. occupies 9 cu.ft. Where superheated to 20 deg. F., a pound fills approximately 9½ cu.ft. In other words the compressor, at the same r.p.m., can handle only 94 per cent of what it could handle if the vapor was dry saturated.

If the suction line is long and uninsulated, the suction vapor may be superheated a considerable amount. Insulation of the pipe-line wire eliminates the superheat. In many plants the small pipe diameter causes a pressure drop in the suction line, which obviously causes the compression work to be increased both through a lower suction pressure and through superheat. Also, the capacity of the machine is reduced, for the volume occupied by a pound of ammonia at the lower pressure is increased; less weight of ammonia is then circulated per revolution of the compressor.

A second serious loss when the suction vapor is superheated is the extra work needed to raise one pound of

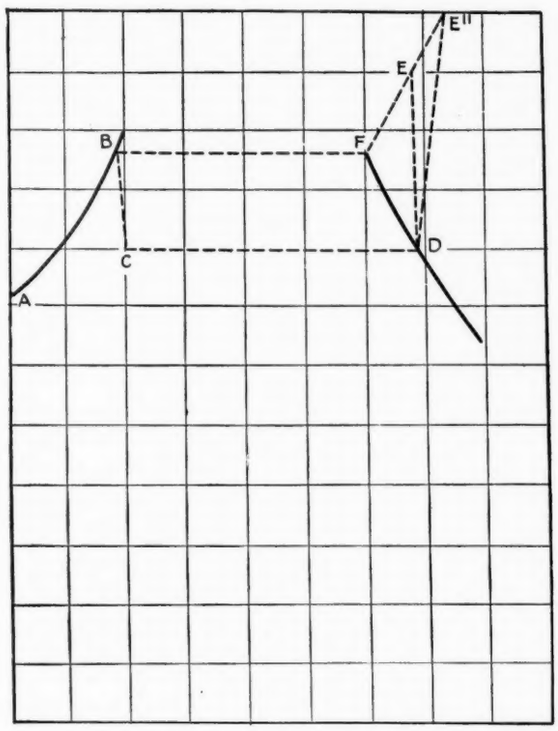


FIG. 3—LEAKS OR HEAT ABSORPTION INCREASES COMPRESSOR WORK

ammonia from *D′*, Fig. 4, to the discharge point, for the compression must be enough to enable the gas to reach the condenser pressure before the discharge valves will lift.

As has been briefly mentioned, if heat is lost to the cylinder walls, the line *DE* will move not vertically, but inclined to the left as in Fig. 2. This serves to reduce the compression area and would be of advantage. However, in a single-cylinder compressor there is little cooling and the compression is fairly adiabatic, especially in high-speed machines. It is not unusual to find the compression line *DE* sloping toward the right, even though the compression line on the indicator diagram be under the adiabatic. This is for the reason that the gas is leaking out of the cylinder space and the weight of gas handled grows steadily less as the compression proceeds. On the heat diagram leaks past the piston or through the suction valve cause the compressor ratio and the discharge temperature to run above that due to adiabatic compression of the original weight of ammonia, the line being somewhat as *DE″*, Fig. 3. Not

only is the work area increased, but in addition the net weight of ammonia handled decreases as will be seen by the volume lines shown in broken lines. The final discharge temperature is higher and the amount of heat to be removed by the condenser cooling water is increased.

High discharge temperature is also caused by the superheating of the vapor as it passes through the suction valve. This superheating causes the point *D* to be moved up along the superheat line, increasing the work of compression and decreasing the net weight of ammonia handled per stroke.

If the discharge temperature and pressures are known, the discharge point *E* may be located at once. The suction pressure and temperature readings determine the position of *D*. If the latter is not virtually below *E*, suction-valve superheating or piston leaks exist.

To make use of this chart, it may be placed under a sheet of cross-section paper or tracing paper and both then placed on top of a glass plate, under which is placed an electric lamp. The chart is then seen quite plainly through the paper and temperature and pressure readings set off on the outline. Thermometers must be placed: (1) At the end of the coils; (2) at the compressor suction; (3) at the compressor discharge; (4) at condenser inlet and outlet; (5) on the cooling-water line. Pressure gages should be at the compressor suction and at the condenser. With readings from this instrument a comparison may be quickly made. This is a practical method of checking the plant's performance and gives results.

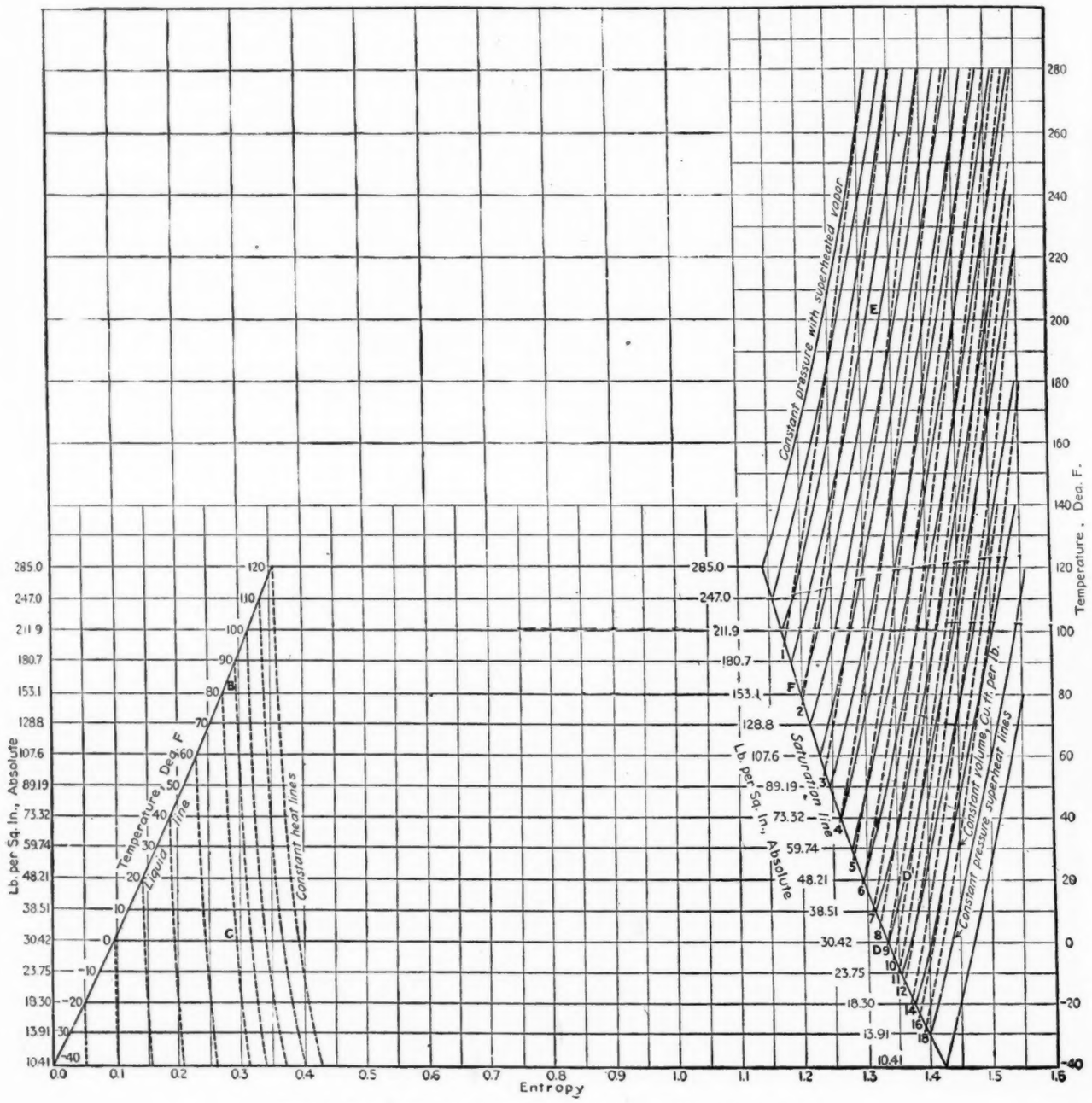
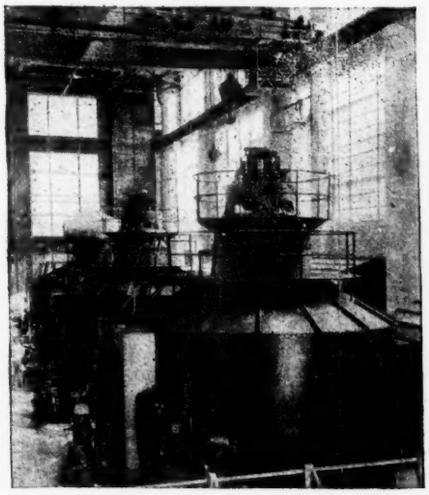
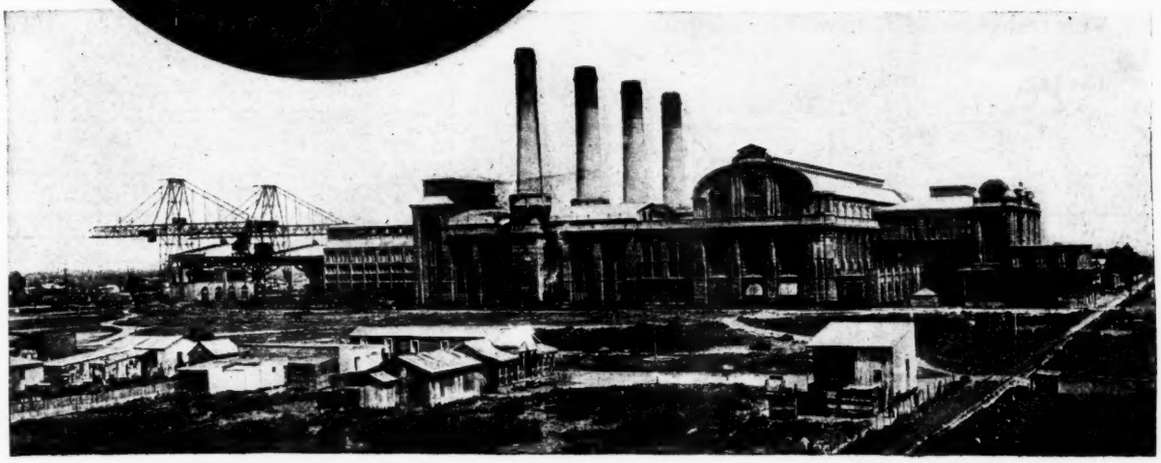


FIG. 4—HEAT DIAGRAM USED AS A PERFORMANCE CHART

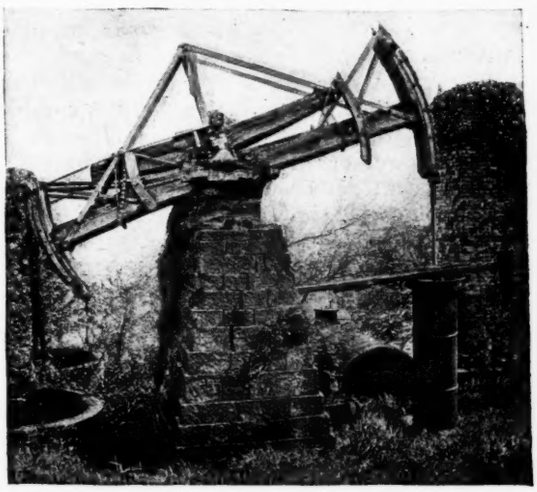
The late Dr. Steinmetz combined work and recreation at his Mohawk Camp



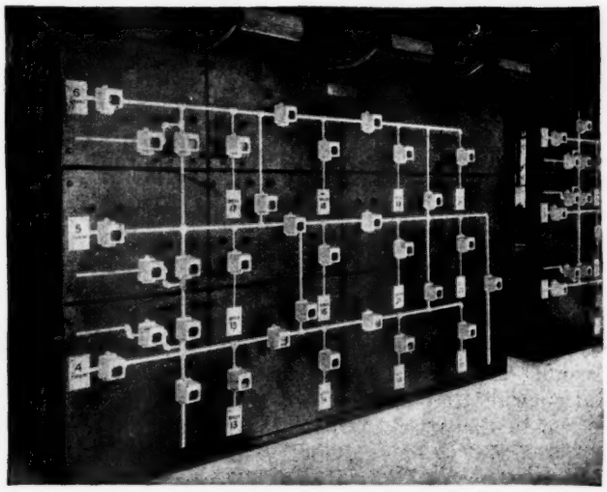
These three 35,000-kw. hydraulic turbines at Big Creek Station No. 3 are the largest on the Pacific Coast



Dock Sud Plant, Compania Hispano-Americana de Electricidad at Buenos Aires. This plant, built some years ago, is now being brought up to date and with the addition of three new 25,444-kw. turbo-generators will have a capacity of 127,000 kw.



Relic of Newcomen pumping engine used nearly 100 years ago and still standing at Fairbottom, England. Acknowledgment is made to W. H. Allan Sons & Co. and to Mr. Lough Pendred for use of the photo



One of four centralized valve control boards constructed for the Philadelphia Electric Company by Payne Dean, Ltd. Each board carries a complete mimic piping diagram and controls 33 high-pressure steam-line valves. Where the valves are placed in the line, a push button is mounted on the switchboard

Parallel and Series Connections of Transformers*

Two Transformers Grouped into Five Combinations of Connections To Obtain Different Voltages—Methods of Determining the Voltages and Current

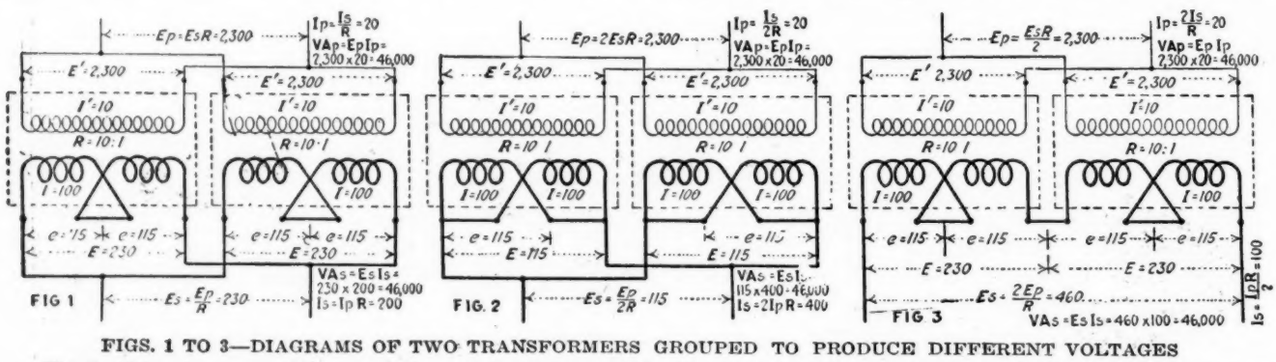
By B. A. BRIGGS

WHEN transformers are connected in groups, they should be of the same type and size and the polarity should be known, or difficulty may be experienced before satisfactory operation is obtained. In the different combinations of connections discussed in the following, these conditions will be considered as being satisfied. Where it can be conveniently done, it is best to supply a single-phase load from one transformer. But if a transformer of sufficient capacity is not available, two or more may be connected in parallel to obtain the desired capacity.

In Fig. 1 two transformers are shown connected in parallel on both the primary and secondary sides. Assuming both transformers to have the same polarity, it is seen that they are connected just the same as two batteries are grouped in parallel. That is, like poles are connected to like poles and a lead brought out from each of two poles, connected together. When two batteries or generators are connected in parallel, their voltage is not increased, but is that of one unit. Likewise, when two or more transformers are connected in parallel, the voltage of the group is that of one as indicated in the figure. If the line volts are 2,300, then each transformer will have to be good for 2,300 volts. Then if the ratio of the transformer is 10 to 1, the secondary volts E of each transformer are $2,300 \div 10 = 230$. Since the secondaries are connected in parallel, the line volts E_s will be 230, the same as for one transformer. Where both sides are grouped alike, the same formula for figuring the primary and secondary volts and current that applies to a single transformer, as discussed in the article "Operation of Static Transformers," in the Oct. 9 issue, applies to a group.

In Fig. 1 the secondary line volts E_s equal the primary line volts E_p divided by the ratio R, or in this case $E_s = \frac{E_p}{R} = \frac{2,300}{10} = 230$. Conversely, the primary line volts $E_p = E_s R = 230 \times 10 = 2,300$. If there is a 200-ampere load on the secondary, then each transformer will have to supply 100 amperes secondary current. Since the ratio is 10 to 1, the primary current will be one-tenth of the secondary for each transformer, or $100 \div 10 = 10$, or the two transformers will take $10 \times 2 = 20$ amperes from the line. In other words, the primary current $I_p = \frac{I_s}{R} = \frac{200}{10} = 20$ amperes, and the secondary current $I_s = E_p R = 20 \times 10 = 200$ amperes, as shown on the figure.

The volt-amperes on the secondary side are equal to the secondary volts E_s times the secondary current I_s, or $VA_s = E_s I_s = 230 \times 200 = 46,000$. Likewise, the primary volt-amperes, VA_p equal the primary volts E_p times the primary amperes I_s, on $VA_p = E_p I_p = 230 \times 20 = 46,000$. The watts would be obtained by multiplying the volt-amperes by the power factor. The values given in Fig. 1 are theoretical, but are close enough for practical purposes, besides considering the theoretical transformer greatly simplifies the problem. For this reason in all the other examples theoretical values will be considered.



FIGS. 1 TO 3—DIAGRAMS OF TWO TRANSFORMERS GROUPED TO PRODUCE DIFFERENT VOLTAGES

Fig. 1—Primaries connected in parallel; secondaries in parallel. Fig. 2—Primaries connected in parallel; secondaries have the winding sections connected in parallel and the transformers in parallel. Fig. 3—Primaries connected in parallel; secondaries connected in series.

By connecting the two sections of the secondary of each transformer in parallel as in Fig. 2, the secondary voltage will be reduced to 115 volts. Then if the two transformers are connected in parallel, as in the figure, 115 volts will be supplied to the line. Connecting the two sections of the secondary winding in parallel is equivalent to changing the ratio of the transformer from 10 to 20 or in other words multiply the ratio by 2. The latter is what has been done in the formulas for voltage and current; for example, the secondary volts $E_s = \frac{E_p}{2R} = \frac{2,300}{2 \times 10} = 115$. Decreasing the secondary volts by 2 does not reduce the capacity of the transformer since the current can be increased by 2. For example, if the secondary is good for 100

*All rights reserved.

amperes, each section can supply this value of current, and when the two are connected in parallel 200 amperes can be obtained from each transformer as indicated in Fig. 2. This makes the two transformers in parallel good for 400 amperes instead of only 200 in Fig. 1. Therefore the volt-amperes will be the same for either grouping, or 46,000.

Each transformer, Fig. 1, develops 230 volts on its secondary winding. If the secondaries of the two transformers are connected in series as in Fig. 3, then 460 volts will be obtained on the line as indicated. This is the equivalent of having one transformer with a ratio of 5:1 instead of 10:1, which is taken care of in the expression for the line primary and secondary volts and current by dividing the ratio R by 2. That is, the primary volts $E_p = \frac{E_s R}{2} = \frac{460 \times 10}{2} = 2{,}300.$

The capacity of the two transformers will not be changed since, although the secondary voltage has been doubled, the current that they can supply to the line is one-half that for Fig. 1 connections. The secondary winding is good for only 100 amperes, and since all four sections are in series, the line current is the current in the windings or, in this case, 100 amperes. This gives the secondary volt-amperes $VA_s = E_s I_s = 460 \times 100 = 46{,}000$ as in the previous diagrams.

If the line voltage was 4,600 and only 2,300-volt transformers were available, then two could be connected in series as in Fig. 4. This gives 2,300 volts on the primary of each transformer, and with a ratio of 10:1 the secondary volts on each will be one-tenth of 2,300, or 230, as indicated. If the secondaries are connected in series, as in the figure, the line volts will be equal to $230 \times 2 = 460$. Leaving the two sections of the secondary winding in series, Fig. 4, and connecting the two transformers in parallel on the secondary side as in Fig. 1, will give 230 volts. With the four sections of the secondary windings, Fig. 4, connected in parallel, as in Fig. 2, a line voltage of 115 will be obtained.

Where transformers are connected in series to operate on a higher voltage than that for which they are

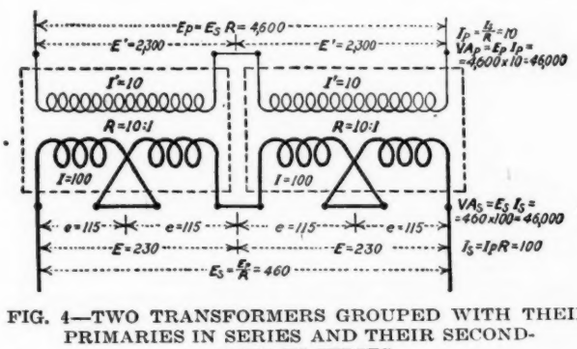


FIG. 4—TWO TRANSFORMERS GROUPED WITH THEIR PRIMARIES IN SERIES AND THEIR SECONDARIES IN SERIES

designed, it is essential that the different transformers be effectively insulated from each other or they will be subjected to excessive voltage strains. This means that the cases must be insulated from ground and must not be in contact with each other.

If for any reason it were desirable to obtain one-half of 115 volts, or 57.5, the primaries of the transformers could be connected in series as in Fig. 5. With transformers rated at 2,300 volts, this would give only one-half rated voltage on each transformer, 1,150 volts. Connecting the two sections of the low-voltage winding in each transformer in series, a ratio of 10 to 1 would be obtained and the voltage is stepped down from 1,150 to 115, or from the line volts, 2,300 to 115, which is equivalent to a ratio of 20 to 1. Each section of the low-voltage winding has 57.5 volts induced in it; therefore, if the two in each transformer are connected in parallel, 57.5 volts will be obtained. Then connecting the two transformers in parallel on the low-voltage side, as in the figure, will give 57.5 volts on the line. Stepping down from 2,300 to 57.5 volts is equivalent to a ratio of 40 to 1. In other words, the ratio of the transformers by the grouping has been increased by 4, as is done in the expressions for finding the voltages and currents. It will be seen that the volt-amperes VA have been reduced by two from that in the other connections. This is due to the rated voltages of the transformers being cut in half. If transformers were used as in the figure, they would be good for their rated current, but their rated volt-amperes or watts would be reduced one-half. Therefore, this connection should be used only as a temporary makeshift and not as a permanent installation except in some cases for testing purposes or similar uses.

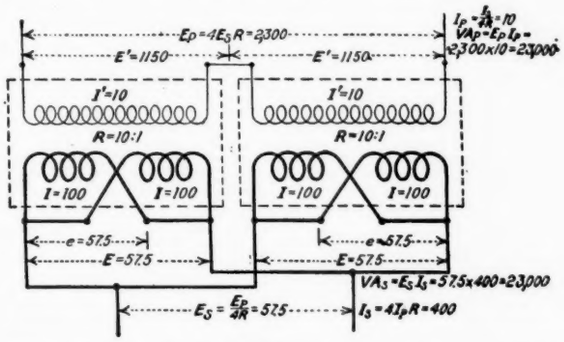


FIG. 5—TWO TRANSFORMERS GROUPED WITH THEIR PRIMARIES IN SERIES AND THEIR SECONDARIES IN PARALLEL

Three transformers may be used for groupings similar to those given in the figures with an even wider range of voltages, but the occasions for using more than two transformers in parallel or series are rare. Grouping two or more transformers to serve a single-phase load should be avoided where possible and a single unit used, since the larger transformer will have a higher efficiency and the connections will be more simple. The next article will take up the different connections for use on two-phase and three-phase circuits.

A determination of the heat reactions in the distillation of coal has been made by J. D. Davis, chemist, Department of the Interior, attached to the Pittsburgh Experiment Station of the Bureau of Mines. Distillation tests were run on various kinds of coal, wood and peat, at various temperatures. Results showed that there were two critical temperatures approximately 475 and 650 deg. C. At these points is the greatest reaction speed in the primary decomposition of coal complexes. In hydrogen below 450 deg. C. in temperature reactions are mainly exothermic, whereas in inert atmospheres (N_2) they are endothermic. At 475 deg. C. it appears that the point of greatest reaction speed in the decomposition of coal is reached. Wood and peat show the same general characteristics as bituminous coal, except there is a more pronounced critical point of 650 deg. C.

Valve Gears on Small Westinghouse Direct-Driven Turbines

Direct-driven valve gears in which the movement of the governor flyball operates the valve through a system of levers, without the use of an oil relay or other auxiliary device, are used on small turbines, up to and including 500 kw. capacity. There are two general types of gears, one for sets up to 15 kw. which uses a horizontal governor mounted on the shaft, and a second type which is applied to geared turbines and utilizes a comparatively low-speed vertical governor geared to the slow-speed shaft. The latter will be described in a succeeding article.

THE smaller turbines are equipped with shaft governors, as shown in Fig. 1. The governor spring is in compression. The stem to the poppet valve contains a spiral spring, also in compression, which tends to exert a constant pressure through the governor lever, to the governor transmission bearing. Thus, if there is any wear or lost motion in the transmission bearing, there will nevertheless be a constant thrust of this small spring to maintain constant contact, causing the valve at all times to follow movements of the governor, positively and accurately.

The governor, shown in detail in Fig. 2 at *B*, contains flyball weights (1) pivoted on hardened steel knife-edges resting in hardened steel blocks (2). These blocks are contained in the governor cage (3). The compression spring (7) pushes inward against the nut

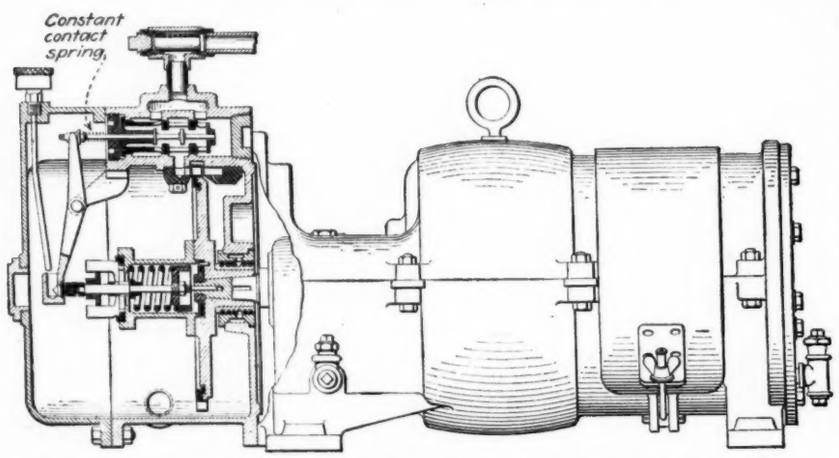


FIG. 1—GOVERNOR ON MAINSHAFT OF SMALL TURBO-GENERATOR SET DIRECT CONNECTED TO POPPET VALVE

(8) at the end of the spindle, as indicated by the arrow. This force is transmitted through a yoke bar (5) which is carried on a shoulder of the governor spindle. From this yoke there are stirrup-shaped links (4) which carry the force from the yoke bar to the governor weights. The governor spring, therefore, tends to close the weights up against the central yoke (10) in resisting centrifugal force.

The movement of the governor spindle is transmitted to the lever, by means of a ball transmission bearing, the steel ball being shown at (9). This ball is carefully insulated from the stem or spindle, by means of fiber bushings in the cylindrical space in which it is carried and also by small fiber disks against which the ball rests. Experience has shown that electrical insulation at this point greatly increases the long-wearing qualities. As explained before, the ball is held against the disks by means of the spring (11) in poppet-valve stem, which makes the governor lever thrust inward toward the governor.

The valve shown in Fig. 2 at *A* is of the double-beat poppet type, inclosed in a bronze cage and contains two seats. No packing gland is provided for the governor-valve stem, but the diameter of the stem is quite small and the fit through the bushing is so long that leakage is negligible.

In very small units this construction is varied. The governor then pushes directly against a small needle valve for admitting steam instead of using the lever and poppet valve as in the present type.

Adjusting Speed and Valve Travel

In making adjustments to this gear, it will be noted that the entire mechanism is carried inside the exhaust casing of the turbine. It is therefore necessary to remove the rear of the casing in order to get at the mechanism. The point of adjustment for the valve travel is the connection of the poppet-valve stem to the governor lever, as indicated in Fig. 2 at *A*. It is not a convenient matter to measure the travel of a governor at this point of adjustment. The travel of the poppet valve, however, is comparatively easy to measure. When a machine is shut down and the exhaust cover removed, push the valve stem in, Fig. 1, until the valve is seated. The spool (12), Fig. 2 at *A*, will slip through the governor lever, against which it is held by the spiral spring (11). When the valve is tight closed, the spool should have been moved inward a distance of $\frac{1}{8}$ in. from the governor lever. In other words, a travel of $\frac{1}{8}$ in. from the adjusted position of the valve, when open, to the closed position, should be the object of the valve-stem adjustment. The spool can be screwed along the stem and clamped in the proper position by means of a locknut.

There are no provisions for changing the number of active turns of the governor spring or mass of governor weights in order to adjust regulation. If a change of this kind is necessary, the proper spring should be obtained from the factory and inserted.

The compression of the governor spring can be increased or diminished by means of the nut at (8), Fig. 2 at *B*. This changes the speed of the turbine. In order to make this adjustment, it is necessary to

remove the governor from the rotor. The speed is correct when the machines are shipped from the factory, and should remain so.

Valve Gears for Auxiliary Drive Turbines

In the case of turbines to drive pumps, fans and similar apparatus, it is necessary that the governor be readily accessible for adjustment, and it might also

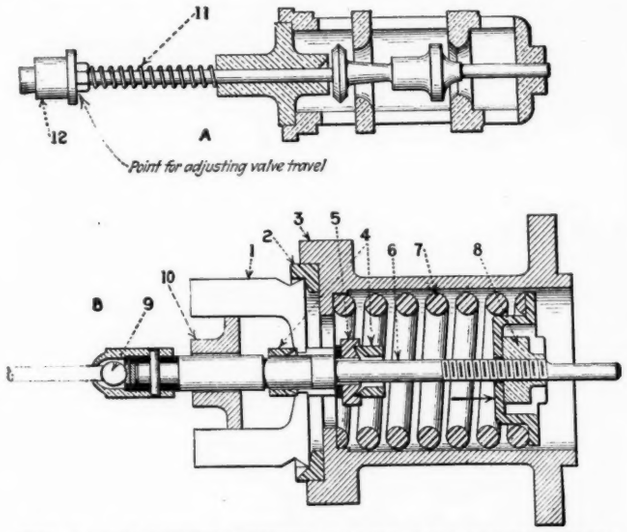


FIG. 2—BALANCED POPPET VALVE AND COMPRESSION SPRING GOVERNOR FOR TURBINES DRIVING SMALL GENERATORS

be said that it must be a very substantial mechanism. Although the regulation should always be stable and reasonably close, it need not be so fine as that required for a turbine driving an electric generator.

With these auxiliary drives a shaft governor is used which is bolted against a suitable flange on the end of the shaft. This has been found preferable to building the governor into the shaft, as it facilitates manufacturing for the governor to be a separate unit, easily fitted together and put on a shelf ready for use. There is also the additional advantage that should the governor be accidentally injured, it is more easily replaced, as a separate unit.

The main spider (4), Fig. 3 at *E* carries two hardened knife-edge blocks (5) in which are mounted the governor weights (6). There is mounted on the turned extension of the spider, a sleeve (28). A governor spring presses against one side of the flange on this sleeve, and the governor weight toe, which is somewhat of the shape of a gear tooth, presses against the other side of the flange.

The compression force of the spring is adjusted by means of the nut (26) so as to fix the speed to be maintained by the governor. As the governor weights move out under centrifugal force, they advance the governor sleeve (28) which in turn is connected to a link (9) through a pin (12) which goes through the sleeve (28) and moves backward and forward through a slot in the spider. This pin (12) is made of steel and hardened; the inside of the hole in the link (9) is also hardened.

The connection between the link (9), Fig. 3 at *E*, and the linkage which moves the governor valve is through a radial ball bearing (15) of the self-aligning type which serves excellently as a thrust bearing with the limited loading it receives in this application. The ball bearing is carried in a bronze sleeve (16) which slides axially in a cast-iron guide (19). The ball-bearing is lubricated by means of a grease cup.

In general it may be said that this construction of the governor is extremely rugged. By omitting the knife-edge and knife-edge blocks from the inner end of the governor weight, a greater simplicity of assembly is obtained and the cost of maintenance becomes a negligible factor.

The connection between the governor, the governor valve and its setting are shown in Fig. 3. Setting of the valve is described in connection with *A*, *B* and *C*. (1) Ref. *A* shows original setting; (2) remove nut 118, Ref. *A*, which gives Ref. *B*; (3) push on end of governor valve stem 116 in direction of arrow until valve is firmly on seat which gives Ref. *C*; (4) measure *A* and set to the proper travel by screwing spool 117 forward or back as necessary; (5) dowel spool 117 and 118 as shown in Ref. *A*.

Where it is necessary to provide means of adjusting the speed while the machine is running, a small knurled wheel (150), Fig. 3 at *D*, is provided. This is pinned to the valve stem, so that by rotating this knurled wheel, the valve stem may be screwed into or out of the block

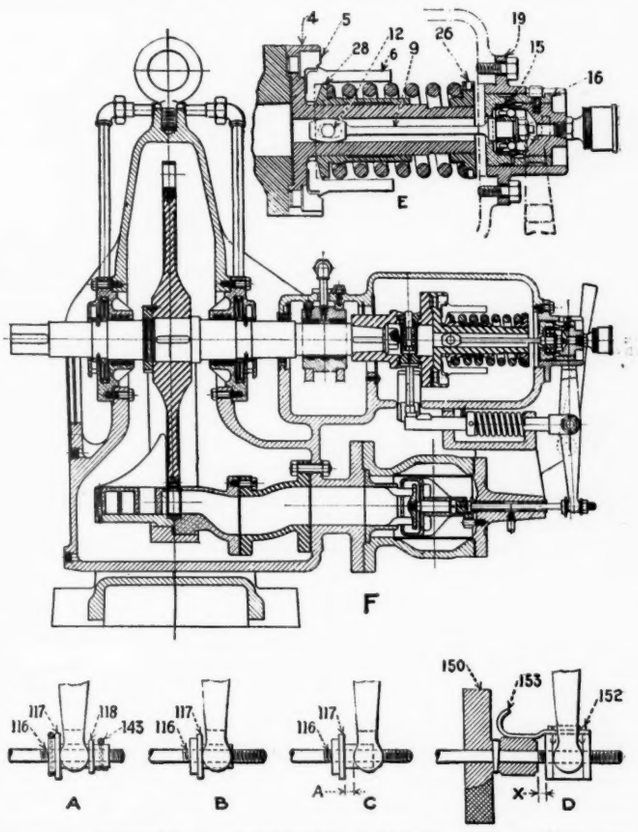


FIG. 3—EXTERNAL GOVERNOR BOLTED TO FLANGE ON THE SHAFT OF AN AUXILIARY DRIVE TURBINE

(152) so as to obtain a different position of governor weights suitable to the speed desired.

The adjustment, when once obtained, is locked by the leaf spring (153) engaging with slots in the periphery of the hub in the knurled wheel (150). This knurled wheel is pinned in such a position that the governor stem cannot be adjusted to prevent valve closure. When the governor has almost reached the limit of its travel, the valve must be firmly on its seat, which position will prevent the turbine from overspeeding.

Notes on Pressure Regulators

By CLAUDE C. BROWN

INSTALLING, adjusting, operating and overhauling of pressure regulators are discussed. There are many points developed from practical experience which may be applied with advantage to maintenance and adjustment. Means of avoiding operating troubles are also set forth.

BEFORE a regulator is installed for pressure reduction service, a definite determination should be reached as to the size and capacity. Liberal allowance should always be made in the choice of size in order to allow for possible increase in demand. Pressure regulators always operate more satisfactorily at rating or a little under rating than at overload. If it is desirable to install and operate several regulators in multiple, the best results will be obtained if all are of the same size, capacity and type.

No pressure regulator should ever be installed without a shutoff valve on both sides and as close to it as possible, with an adequate bypass around the combination. This is essential for the reason that pressure reducers require attention at periodic intervals, when it is necessary to take them out of service, clean and adjust them.

Strainer Prevents Injury by Foreign Particles

In all installations of pressure regulators, a screen or strainer should be placed immediately before the regulator. This screen prevents bits of foreign material from getting into and clogging the small ports and passages of the valve. This is essential for the reason that the accurate operation of the majority of regulators depends on the passage of small amounts of the fluid which is being controlled through small ports of varying size. Any bits of foreign matter that get into these ports or under the auxiliary valve seats prevent free action. In many cases they will score the valves and seats to such an extent as to make further accurate operation impossible until repairs have been made. Another detrimental result occasioned by the lodging of particles of grit or scale between the valves and their seats is the wiredrawing effect of the fluid. This passes between the partly closed valve and its seat and erodes or scores them.

Protect Regulating Valve with a Steam Separator

For the purpose of regulating steam pressure a steam separator should be placed before the regulating valve for removing all condensation from the steam before it is allowed to enter the valve. This separator should, of course, be adequately trapped and kept drained.

All steam-pressure regulators should be located as near the power supply as possible and at the highest point in the line. If this is not feasible, steam traps should be placed so that the line is properly drained on either side of the regulator.

Pressure regulators should be so installed that the weight of the regulator itself, as well as the weight of the fittings and piping leading to and from it, is properly taken care of. Distribute this in such a manner that no undue strains are placed on the regulator flanges.

Place regulators in an upright position in a horizontal run of pipe so that any wear occasioned by the operation of the mechanism will be even all around, with no tendency to bind or become unduly worn.

It is general practice to indicate the proper direction of flow through the regulator by arrows cast on the side of the body. All installations should be made in accordance with this marking.

Place Accessible for Repairs

Pressure regulators should be installed in locations that are accessible and from which the mechanism may be removed either in part or as a whole. This is absolutely essential, inasmuch as a periodical overhauling and cleaning of these pieces of apparatus must be made in order to insure satisfactory and accurate operation.

A suitable pressure-gage connection with stop cock should be provided on the delivery line as near to the pressure regulator as possible. A similar connection should be made upon the supply line, and the two pressure leads brought down to a gage board. This board should be as near the regulator as possible to facilitate reading the pressures when setting the regulator.

Clean Regulator and Pipelines Before Starting Up

Before the regulator is finally set in place, it should be thoroughly cleaned with kerosene and a cotton rag to insure the absence of all foreign matter. The mechanism should then be lightly oiled and carefully put in place.

All lines leading to and from the regulator should be thoroughly blown out to remove scale, shavings, grit and other foreign bits. This is essential in new boiler or air-compressor installations, or in fact in any installation where new pipe lines have been run. Too much care cannot be taken in preventing dirt of any kind from getting into the regulator. Carelessness in this respect is sure to necessitate the opening up of the regulator and taking it apart to remove the obstructions after the pressure has been turned on. The necessary care in this particular may save a lot of trouble and often prevent what might prove not only annoying but serious delay or possible serious injury to the regulator.

Never use white lead, red lead, cement or gum of any kind that is likely to project beyond the edges of the flanges, for making up pipe joints, as any such projections are sure to become detached and find their way along the line and into the regulator.

Drain Before Adjusting

After the regulator has been put in place and all bolts thoroughly tightened, it is ready for operation. Before the pressure is turned on, all drains on regulator, inlet and delivery lines should be opened, to allow any condensed water to escape. In the regulation of steam pressure, the initial pressure should be raised equal to that to be carried and held until the regulator has been set to give the desired working pressure on the delivery side.

After all condensation has been drained from both the inlet and delivery sides and also out of the regulator

the adjusting nut should be loosened until it is free from the diaphragm. At this setting the regulator will pass no steam. The bypass should then be slowly opened to allow sufficient steam to warm up the delivery side of the regulator and delivery piping, after which it should be closed. The stop valve on the inlet side of the regulator should then be opened wide but very slowly. Initial pressure is now on the regulator and the setting is such that the regulator should be tight against it. Next the stop valve on the delivery side should be slowly opened. If the regulator is in good operating condition, it will not allow any steam to pass. All opening of valves should be done very slowly in order to allow all parts to become heated up gradually and all condensation to be carried away freely.

Inlet Valve Should Be Wide Open

After all parts have been heated up and the regulator is holding against the initial pressure, the adjusting nut should be slowly screwed down until the regulator allows sufficient steam to pass to maintain the desired pressure on the delivery side with all drains open. Then the drains should be closed. When the adjusting nut has thus been set at the desired position, it should be locked. The regulator is now in service and should continue to deliver steam at the reduced pressure as long as the initial pressure is maintained constant. However, if the initial pressure is allowed to vary, the delivery pressure will vary in proportion with it.

The regulator should be operated with the inlet valve wide open at all times. If the inlet is throttled and a heavy demand comes upon the regulator, the throttled inlet valve will limit the amount of steam supplied, thus causing a drop in pressure on both the inlet and the outlet sides.

Erratic Action Probably Due to Water

Should the action become erratic and allow the delivery pressure to rise above and fall below the point at which it is set, and it fails to recover itself readily, immediate examination should be made of the steam traps and drains. This trouble may be caused by a considerable amount of water, either from condensation or directly from the steam, which has found its way into the regulator. The erratic action of the regulator will persist until the water has been either drained off by the drains or traps or passed through the regulator. In some extreme cases it has been found necessary to throttle the inlet valve sufficiently to allow the regulator to rid itself of the water, after which the inlet valve should be slowly opened again.

If the delivery pressure consistently rises when the demand decreases until it approaches the initial pressure, there is evidently a piece of scale or other foreign matter lodged between the valve and its seat, which is preventing it from being entirely closed. This condition necessitates the immediate taking out of service of the regulator with dismantling and cleaning.

Do Not Use Knives or Scrapers on Inner Mechanism

When overhauling, the working parts should be thoroughly cleaned with kerosene and a cotton rag. If lead, pitch, gum or other substance has found its way into the regulator, all parts upon which this is found should be immersed in kerosene or similar solvent until the substance has been entirely dissolved. Those portions that are resistant should be removed with a piece of hardwood. Knives or metal scrapers should never be used upon any part of the inner mechanism of a regulating valve. Both valves and seats should be examined carefully to see that valves seat properly all around. To insure this, the valves should be ground, using kerosene only to clean the seats. When after long service it is found necessary to grind the valves, this should be done with fine powdered glass and oil, great care being exercised to see that all the glass is removed after the grinding has been finished. After being cleaned, all parts should be wiped thoroughly dry with a clean rag before being re-assembled.

Avoid Coarse Flake Graphite in Making Up Joints

In re-assembling the regulator, the parts should work freely and without binding. All joints should be thoroughly cleaned and all gaskets should be free from burrs or breaks. Bolts should be dipped in powdered graphite mixed with light oil to insure or rather to facilitate future removals. Powdered graphite and oil may also be used on the gaskets in making up the joints, to insure their being steamtight. Care should be taken, however, to use only a sufficient amount to smoke the gasket, as too much is worse than none at all. In no case use coarse flake graphite, red or white lead, or any kind of cement or gum in making up the joints of the regulator. Some of this material is sure to find its way into the regulator and prevent satisfactory operation.

Some Remarks on the Life of a Diesel Engine

A continuation of letters passing between two engineers on the subject of oil engines. The first discussion, Power, Oct. 16, was on initial costs.

Pittsburgh, Pa., Aug. 27, 1923.

Mr. John Haite,
Worcester, Mass.

Dear John:—You have by this time gone over my letter regarding the initial cost of a Diesel power plant, and I hope that you will check my figures by obtaining estimates from two or three of the well-known builders.

As I promised you, I am going to write fully about the overhead charges that should be set down against this type of plant. Overhead is made up of four items, these being, interest, depreciation, taxes and insurance, and they are usually taken as a percentage of the capital investment in the plant. Since each of them, as I will show later, depends on the useful life of the plant equipment, I think it best to deal first with this point of machine life.

At the time our company made our investigation, the results of which have not yet been acted upon, we obtained from several builders a list of all their Diesel engines manufactured prior to 1916. We looked up each one of these engines and found that every one was still in service with the exception of approximately 2,000 hp. Some of the engines built in 1904 to 1909 had been resold but were still in operating condition. We went further and tried to locate engines that were offered for sale and to our surprise could find but six. One of these, a 225-hp. unit, built in 1907, was sold to other parties for more than one-half the first cost, having lost in 16 years less than one-half of its commercial value.

We likewise found that in many instances where an engine had been resold and was more or less worn at the time, the purchaser had, at the expenditure of usually less than 20 per cent of the cost of a new engine, completely overhauled and placed it in a condition as good as when shipped from the factory.

Upon studying the matter, this does not appear surprising. An engine, oil, steam, or whatnot, is a matter of a lot of castiron, some steel and bronze, etc. No matter what its age may be, outside of a wreck destroying the entire machine, the physical thing that makes it old or useless is the wear of the pistons, cylinder liners and small parts. Taking the case of a steam engine, for example; after 20 years of life the engine still remains upon the foundation. It may be badly worn, but reboring of the cylinder, a new piston, new bearings and valve gear will give it a new lease on life and it will be ready to run 20 years longer.

The same holds true for an oil engine. After 12, 15 or 20 years, as the case may be, an overhauling costing 20 per cent of the first cost will put the engine back into its original condition.

It is my opinion, then, that the engine's useful life should be set at 25 or 30 years. I can easily conceive of a situation where, owing to manhandling, a machine may last only a few months, but when considering the life of any type of engine, the natural assumption is that the management will employ intelligent or skilled men.

I had intended to cover the overhead charge subject, but this must wait, for I have become so interested that I want to work out a chart. More to follow.

With the best of intentions, JIM.

Worcester, Mass., Aug. 31, 1923.

Mr. J. R. Stowe,
Pittsburgh, Pa.

Dear Jim:—I was quite interested in what you state is the life of a machine. I agree without argument that a steam engine, after working 20 years, can be placed back into its original mechanical condition by an overhauling; in fact, I think 20 per cent is high for the overhauling. But mark this, our steam plant is only 15 years old and, as far as the engine room is concerned, is in as good operating shape as when new; the boilers, however, while they look O.K., have had their pressure reduced twice by the insurance companies. In the face of the good condition of the steam engines we are going to junk them simply because the steam consumption is high, and install more modern units.

So you see, Jim, your argument about 20 years' life for an oil or a steam engine is all right, as far as it goes, but you overlooked the fact that perfectly good engines are scrapped just because they call for too much coal. What have you to say as to this in the way of a comeback? Yours, JOHN.

Pittsburgh, Pa., Sept. 3, 1923.

Mr. John Haite,
Worcester, Mass.

My dear John:—From your letter I see that I failed to get my idea across. I was discussing the physical life of machines, while you actually are interested in and are discussing the useful life.

There is no doubt that there is, with most types of machinery, a difference between what may be called the physical and the useful existence of an engine. My statement that a steam engine, as well as an oil engine, after twenty years of operation, can be put into first-class shape at a cost of, maybe, 20 per cent of its first cost, is true. But here is the rub. Most types of machines find their usefulness shortened by the development of more efficient units. For example, Watt's original steam engine compared with man or animal power was very efficient, but was soon followed by steam engines that used only one-half the amount of steam per horsepower-hour. George Corliss' engine shown at the Centennial Exhibition in 1876 was a wonderful machine and after the show was over supplied power to the Pullman shops for years. Even when it was junked its efficiency had not decreased substantially from that shown in 1876. What put it on the shelf was the fact that a steam turbine would use so much less steam that there was a loss in running the Corliss.

You might say, for many so claim, that unless a new machine showed a high enough efficiency so that the money saved paid the fixed charges on the new investment, it would pay to keep the old machine. This reasoning is probably correct if the engine is in a factory that is making a product that has no competition. But, almost without exception, all manufactured goods are sold in a competitive market and cost is a large factor in making sales. A new factory may start up and, being equipped with the most modern of machinery, be able to turn out stuff at a price far below the costs in a plant having old machines. It is necessary to safeguard against this by laying aside a fund during the prosperous or less competitive years so that when a competitor can manufacture cheaper, you are able to make use of this fund in re-equipping the factory. This obsolescence or, as it might be called, "rainy day" fund, in effect makes the purchaser of today help reduce the price to tomorrow's customer—a not altogether fair treatment to the folks of today, but the practice is universal. Anyhow, if this obsolescence charge was not banked, it would simply be handed over to the stockholder as extra dividends. Furthermore, as a protection to the bondholders, if there be any, a liberal depreciation fund is advisable. This, however, does not indicate that the actual wear and tear is high. Public service commissions have in many cases set the depreciation of a public utility's plant at 4 to 5 per cent.

In your first letter you indicated that your people were up against this very proposition of underselling. It follows that many a good machine is discarded to make room for a more efficient one.

The advance in steam engineering has been such that 10 to 15 years marks the useful, or I might call it the competitive, life of a steam plant. We might say that it becomes obsolete in 12 years, although it would be in good condition after 20 years. It is for this reason that instead of a depreciation (or wear-and-tear) charge of 5 per cent per year to enable the owner to have charged off the cost by the time it was 20 years old, it is customary to make a charge of 8 per cent in order to charge off the investment in 12½ years; in doing this, the charge may be called a depreciation or an obsolescence charge, as fancy dictates.

Now in the case of a Diesel engine this condition does not exist. The thermal efficiency is high, say 30 per cent, and the best that any steam plant has been able to do is 19 per cent. This efficiency of the steam plant that I am giving as the maximum possible under the present-day steam pressure, is about as good as can be expected for years. To equal the oil engine's efficiency, steam pressures must be raised to 2,000 or 3,000 lb.

per sq.in. Even the combination of a plant using steam with one using mercury will not reach the oil engine's over-all efficiency.

Furthermore, the efficiency of the Diesel engine has not been materially improved since the appearance of the first one in 1898, the gain for a given size being not over 5 per cent. In addition the small units are about as economical as the large ones. For example, in 1906 several 225-hp. units were tested in this country and showed a fuel consumption of 0.43 lb. per b.hp. as an average; at the present time units of even 6,000 hp. do but little better, the larger units delivering a brake horsepower-hour per 0.385 lb.; this is a decrease in fuel consumption of but 10 per cent.

I naturally conclude that as long as a Diesel is mechanically in good condition, it is in no danger of being discarded by reason of an increase in power demand or by the production of a more efficient engine. If more power is ever needed, an engine of suitable size can be added.

One Diesel manufacturer gave us very complete data on the life of its product. It was shown that 136 central stations had 263 engines of this make. Of this number, 5 are operating in their 20th year or longer; 15 in their 19th or longer; 26 in their 18th or longer; 42 in their 17th or longer; 47 in their 16th or longer; 51 in their 15th or longer.

If the life of an engine was assumed by the central stations when figuring costs to be but 12 years, then the owners of these 51 engines have recovered the capital invested several years ago and from now on should charge no depreciation or interest on invested capital.

Of Diesels sold to central stations during the last 20 years, over 98 per cent are still in service. I think this representative of what to expect when an engine is well taken care of as your plant would be, for since power is the product sold by the central station, the cost of power is 100 per cent of the cost of the article sold and the machinery is kept in condition to work at the lowest possible cost.

One should not neglect the resale value of machinery. There is always a possibility that a factory may be dismantled by reason of the product having lost its market. The second-hand value of the machinery is then of importance. Of course, resale prices vary over a wide range, but I believe, in view of prices at which second-hand Diesels have been sold, that we should figure getting at least 40 per cent of the price of a new engine after a life of 10 to 12 years. In some instances over 60 per cent has been recovered on engines built in 1905 to 1907.

I'm going to write you tomorrow on real overhead charges. This is a subject of which little has been said. Engineers as a rule assumed a standardized percentage, which may or may not represent the actual percentage. But do not think this is going to develop into a serial story for you.

With best regards, JIM.

The "Thirty Year Review," published in pamphlet form by the General Electric Company, indicated that in 1912 their orders reached $100,000,000 worth for the first time. In 1920, the total was over $300,000,000, and in 1922, $220,000,000.

Don't permit rubbish to accumulate in basements, workshops or anywhere about the premises.

Steam vs. Electric or Gasoline Drive for Centrifugal Pumps*

In operating a centrifugal pump, there is considerable difference in the fuel costs of the three types of drives commonly employed; that is, the steam turbine, electric motor and the gasoline engine. The accompanying data, comparing the three types of drives for a specific pump, were submitted recently and may be of general interest. The pump in question was a 14-in. double-suction volute pump, directly connected in the cases of the electric motor and gasoline engine, and with the turbine gear driven.

With a capacity of 4,200 gal. per min. the pump operates at 1,200 r.p.m. against a head of 140 ft. at an efficiency of 80 per cent, the driving energy required at rating being 186 hp. The values taken to work up the comparative data are given in Table I.

TABLE I—GENERAL VALUES ASSUMED

Cost of electricity per kw.-hr., cents	2
Cost of coal per ton, dollars	4.50
Cost of gasoline per gallon, cents	20
Efficiency of motor, per cent	90
Gasoline consumption per hp.-hr., lb.	0.65
Gasoline weight per gal. (68 test), lb.	5.94
Heat content of coal, B.t.u.	12,000
Feed-water temperature, deg. F.	210
Boiler efficiency, per cent	65
Water rate of turbine, lb. per b.hp.-hr.	13.7
Gear efficiency, per cent	98
Steam for condenser air pump, lb. per hr.	125
Steam for turbine seal, lb. per hr.	100

TABLE II—GENERAL SUMMARY

Type of Drive	Cost of Unit	Weight, Lb.	Fuel Cost per Hour	Cost per 1,000 Gal. Water
Steam	$7,500*	20,500	$0.90	$0.0036
Electric	2,800†	8,600	3.08	0.012
Gasoline	4,500‡	8,000	4.07	0.016

* Includes waterworks type condenser and air pump. † Includes 200 hp., 2300-volt motor with hand starter. ‡ Includes 8-cyliner gasoline engine with electric starter.

For this comparison steam conditions were taken as 200 lb. gage initial pressure, 150 deg. F. superheat and 28 in. vacuum. When pumping at the rated capacity and allowing 100 lb. of steam per hour for the steam seal and 125 lb. per hour. for the air pump, the total amount of steam required per hour is $\frac{186}{0.98} \times 13.7 + 225 = 2{,}825$ lb. This figure corresponds to a duty of 113,000,000 foot-pounds.

In determining the cost of the steam, the heat units per pound supplied by the boiler were obtained by subtracting the heat of the liquid corresponding to 210 deg. F. from the total heat of the steam at 200 lb. pressure and 150 deg. superheat, giving 1,284.5 — 178 = 1,106.5 B.t.u. Multiplying this figure by the total pounds of steam gives the B.t.u. per hour and by taking into account the boiler efficiency, the B.t.u. in a pound of coal and the cost of the coal per ton, it was found that 400 lb. of coal per hour, costing 90c. would be required. This figure reduces to a fuel cost of 31.86c. per 1,000 lb. of steam.

For the electric-motor drive it will be recalled that the power requirement of the pump is 186 hp. Reducing this to kilowatts and taking into account the motor efficiency of 90 per cent, gives an input to the motor of $\frac{186 \times 0.746}{0.90} = 154$ kw. At 2c. per kw.-hr. the cost of current per hour to run the pump is 154 × $0.02 = $3.08.

In Table I it will be seen that the gasoline engine requires 0.65 lb. of gasoline per horsepower-hour. To develop 186 hp. requires 186 × 0.65 = 121 lb. of gas-

*Data submitted by the Hill Pump & Turbine Works of the Midwest Engine Corporation, Anderson, Ind.

oline per hour. With 5.94 lb. of gasoline in a gallon, the preceding figure reduces to 121 ÷ 5.94 = 20.35 gal., which, at 20c. per gal. amounts to 20.35 × $0.20 = $4.07 per hour.

A general summary of the preceding data is contained in Table 2. This shows that the fuel cost for the steam turbine is much lower that the equivalent cost for the electric motor or the gasoline engine. The figures do not take into consideration the fixed charges, labor and depreciation, all of which would be greater in the case of the steam drive as compared to the electric motor. Other factors to be considered are readiness to serve and the stand-by cost. Owing to these factors and the ever-increasing developments in the hydro-electric and superpower station fields, electric-driven centrifugal pumps using a gasoline-driven standby unit, are becoming popular.

Meeting the Emergency at Logan

During the latter part of September an emergency arose at the Logan station of the Kentucky & West Virginia Power Co., the efficient handling of which reflects credit on the operating force. At the time three turbines were in operation, two old 5,000-kw. units and a relatively new 15,000-kw. unit. A second 15,000-kw. unit similar to the first was being erected.

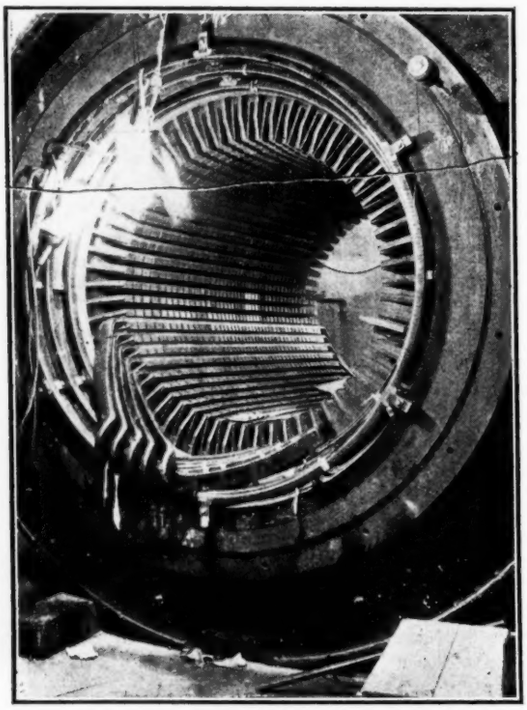


FIG. 1—STATOR OF BURNED-OUT GENERATOR BEING REPAIRED

About 1 p.m. Sept. 18, while J. R. Wampler, the plant engineer, was on his way to the station, he noticed the wires of the transmission line had burned down in a number of places and learned a few moments later that the 15,000-kw. unit was down with the armature coils burned out. Investigation failed to disclose the exact cause of the occurrence. Both the wattmeter record of 26,000 kw. on the generator circuit and the fact that the transmission line melted down in a number of places gave apparently conclusive evidence of a heavy overload, probably due to a falling feeder line. At the same time none of the three circuit breakers that would usually protect the circuits opened up. These breakers were located as follows: One on the feeder line, one on the transformer bank and one on the generator circuit, the last-named circuit breaker being set to open at about 20,000 kw. The mystery is increased by the fact that a test of the breakers the next day showed their mechanical condition to be perfect.

The station operating force immediately got on the job and, with the assistance of several outside men

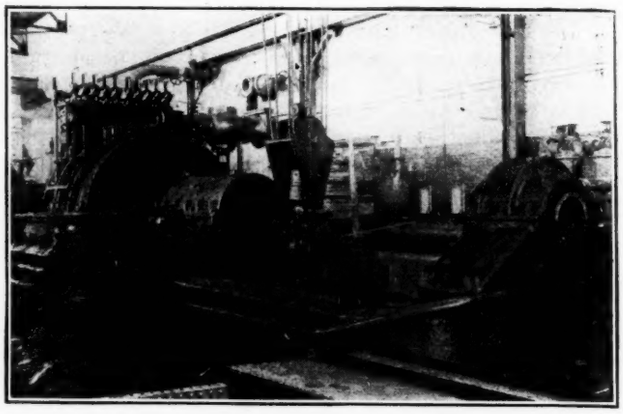


FIG. 2—NEW TURBO-GENERATOR BEING ERECTED

(making a total force of nine) had the electrical end of the unit removed by 10 a.m. the next day. Inspection showed that the damage was confined mainly to the insulation of the armature windings, although the heat from the armature did burn out the spacing blocks at one end of the rotor.

Immediately after the accident plans were made to replace the burned-out generator by that of the new 15,000-kw. unit under construction, the parts of which were lying around the station. While this unit was similar to the damaged one, there was minor differences, chiefly in the drilling of the generator feet and bedplate. The electrical end of the new unit was lined up on the bedplate of the old. It was necessary to redrill sixteen 2¼-in. holes through 3 in. of steel in the generator feet and 3 in. of cast iron in the base. It was also necessary to refit the old bearing on the generator end.

After tapping the holes, lining up the generator and bolting it in place, it was necessary to refit the end bells and generator lagging. To avoid delay the unit was dried out at 80 deg. C. with current from an exciter while the holes were being drilled and tapped.

At 5:30 a.m., Sept. 24, less than six days after the accident, the unit was on the line again. The old armature was removed to the basement, where new windings are now being fitted. The rotor was shipped back to the factory for repair. The damaged windings are being re-insulated and will be kept on hand as spares.

Erection of the new unit is proceeding, and by January, 1924, it will probably be in operation with the repaired electrical end of the damaged unit.

While the unit was down, partial service was maintained by supplying half of the customers one day and half the next.

Three new 10,000-sq.ft. boilers with 11-retort stokers will be in operation by the first of the year to supply the new turbine.

EDITORIALS

F. R. LOW, EDITOR

Corrosion or Erosion?

HYDRAULIC turbine runners may become worn owing to two chief causes, corrosion and erosion, either or both of which may occur on the same runner. Corrosion is manifested by a pitting or eating away of certain parts of the runner or other parts of the turbine, probably due largely to electrolytic action between oxygen liberated from the water or, in some cases, impurities in the water and the component parts of the metal. This statement is to a large degree substantiated by experiences where lead or other metals dissimilar to the runner have been attached to the crown plate for balancing purposes, and serious corrosion has occurred around the balancing metal. In such cases a short-circuited galvanic cell is actually produced when water conditions are favorable.

The design of hydraulic turbines has been so far developed that it is possible to build runners that will not corrode under conditions for which they are designed except from impurities in the water. However, corrosion can and does occur on account of improperly designed runners or from operating at part loads or overloads for long periods. In these cases voids are formed in the buckets where oxygen is liberated from the water which sets up electrolytic action between the impurities in the metal and the metal itself in the runner. In many cases corrosion of a runner has been eliminated by changing the design. On the other hand, runners have operated for considerable periods without pitting, and when for some reason it becomes necessary to operate at part gate or to overload the unit, corrosion has developed.

Turbines in water-power plants must operate under all kinds of conditions and have to pass the water through them, in most installations, carrying all but the larger foreign materials. During the winter months it is not an uncommon practice to raise the racks and let large quantities of ice carrying other foreign materials through the runners. In other locations whenever heavy rains occur large quantities of silt and sand are carried in suspension in the water and cause erosion —an actual wearing away of the runner buckets and seal rings. Pitting of the runner is unquestionable due to corrosion, but a wearing away of the metal may be the result of either corrosion or erosion or both. Recent experiences with an installation of large high-head reaction wheels lead to the belief that in some cases where it was thought that the trouble was due to corrosion, erosion may have caused the difficulty. In this plant there are two 22,000-horsepower units operating under an 800-foot head, which have been in operation for nearly two years and the runners are still in good condition. This is due largely to the runners being of proper design, but preventing sand and silt from passing through the runner has also been an influence. In this installation a large sand box is installed where the velocity of the water passing to the plant is reduced to about one-half foot per second, allowing the sediment in the water to settle out. After several months' operation inspection revealed that about six inches of sediment had been precipitated to the bottom of the box. This silt was so fine that forty-five per cent of it would pass through a 150-mesh screen. Considerable quantities of silt of this fineness could be carried in suspension in water without any serious attention being given to its presence and where this material is of the proper character it might cause serious erosion of the runner. It may be that in some of the cases where corrosion of the runner was supposed to occur without any apparent reason, it was not corrosion at all, but erosion caused by a very fine sediment in the water.

"Practical" Boiler Efficiency

"WHAT is boiler efficiency?" is the question propounded by G. A. Rossetti in the September issue of the British journal, *Cheap Steam*. "Assuming," he says, "that the *facts* of a test are known as to quality of fuel used, quantity and condition of evaporation produced, conditions of combustion, etc., what is the correct figure for efficiency?" As ordinarily considered, the answer is that the efficiency is the ratio of the heat effectively used to that in the fuel (as measured by a calorimeter). This definition does not satisfy the author of the article, and he appeals to the steam-engine field for a helpful illustration. It would be unfair, as he views it, to say that a perfect engine was wasting sixty-three per cent of the energy supplied if it were operating under conditions for which the Rankine cycle had an efficiency of thirty-seven per cent. The fact remains that the engine *would* be wasting that amount although the waste ought perhaps to be labeled "unavoidable" to prevent its reflecting on the ability of the engine designer.

But the relative advantages of the thermal and Rankine efficiencies of a steam engine need not be argued here. Both are useful and both may easily be figured in accordance with rules that are definite and generally agreed upon. By figuring and reporting both efficiencies everyone is satisfied. We may admire the designer of an engine that has a Rankine efficiency of eighty per cent, but if the thermal efficiency is only five per cent, we see that the over-all results are nevertheless very poor and seek the trouble at once in a throttle pressure that is too low, an exhaust pressure that is too high, or in both together.

Mr. Rossetti seeks to devise a "practical" boiler efficiency that will correspond to the Rankine efficiency of an engine. He apparently intends this to replace the present boiler efficiency. This would be as distinct a loss as would be the discarding of thermal efficiency in steam-engine computations. The point need not be stressed, however, as the over-all thermal efficiency could still be figured, whenever desired, along with the new "practical" efficiency. The big objection lies in the impossibility of getting engineers in general to agree

upon any methods of figuring the fraction of the heat in the coal that is practically available.

To consider the point most difficult to agree upon, What is the lowest practical flue temperature? Mr. Rossetti fixes it at 212 degrees on the assumption that condensation will forever make lower temperatures impracticable. At the present time this limitation doubtless holds, but who can say that future developments in corrosion prevention will not make possible the recovery of the latent heat of flue-gas moisture, Is it not much better, in the present state of the arts of combustion and heat transfer to stick to the present method of figuring boiler efficiency as the ratio of heat output to heat input and make a separate listing of those practical factors that should be considered when comparing the performances of boilers operating with different fuels and under different conditions? The only other course is to set up standards of practical perfection that will almost certainly be discarded or modified in a few years.

Where House Turbine Is More Economical Than Bleeding Main Unit

THE house turbine is usually installed for purposes of economy or reliability or both. By returning to the system part of the steam generated without the condenser losses, after extracting power until the desired condition of the returned steam is reached, station economy is improved over that of a straight condensing plant.

As a means of preventing interruptions to the supply of auxiliary power the house turbine may act as a reserve unit. This is well exemplified in the case of a house turbine placed in multiple with the main station bus as well as the auxiliary bus. Load can be regulated to suit requirements of steam temperature, but in the event of failure of the main generators, the house turbine may be automatically cut apart from the main bus and utilized in maintaining auxiliary power.

We have passed through eras of steam-driven auxiliaries as well as house turbine assisting to supply electrical power for auxiliary drive. Now, with the application of bleeding the main units for heating feed water, comes the question of additional generators, driven by the main units, for auxiliary current supply, perhaps supplanting the house turbine. This is reasonable from the fact that the over-all efficiency of a house turbine is ordinarily lower than the equivalent efficiency of a main unit. Although a large part of the turbine losses appear as heat in the exhaust or extracted steam, total plant efficiency is nevertheless lowered where such losses occur. Generally speaking, for a given temperature to which the feed water must be heated, there is a greater condenser loss where such inefficiency exists; more steam must be supplied the prime mover for maintaining an equal load, requiring also a relatively greater amount of extracted or exhausted heat, for increased amount of condensate. The question of relative efficiency, therefore, may have an appreciable bearing on over-all station economy.

Where alternating current for auxiliaries is used, the house turbine exists largely for purposes of reliability. When auxiliaries operate on direct current, however, a house turbine may be more economical than entire or partial bleeding of an alternating-current main unit for heating condensate.

Large prime movers may show high over-all efficiency in the use of steam passed partly through and extracted. This advantage, however, may be largely nullified when direct current is furnished for auxiliary power by means of a motor-generator set. Here approximately fifteen per cent of power taken by the main unit from extracted steam is lost in conversion. These losses are not returned to the boiler through extracted steam.

Direct-current house turbine units, particularly for large plants, may be constructed with an over-all efficiency closely approaching, if not exceeding, the resultant efficiency at the direct-current busbars of the main unit, motor-generator combination. Besides, losses in this case are returned to the exhausted steam to a greater degree than with the main unit combination. The house turbine may then be justified by both economy and reliability as reasons for its adoption.

However, for direct-current auxiliary drive a possible improvement in economy may be obtained by driving direct-current generators from the main units, with the usual bleeding for heating feed water. This brings up complications of construction or gearing as well as electrical control. In case the main unit emergency valve becomes closed as a result of abnormal conditions, the auxiliary power supply will lack the stability of an independent house turbine.

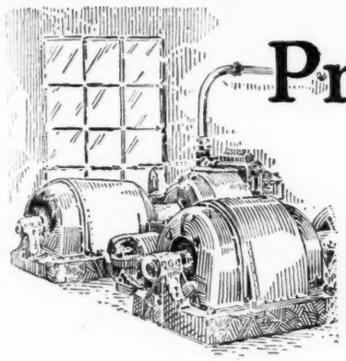
Selection of Near-by Coals

SPEAKING before the American Gas Association at its Atlantic City meeting recently, O. P. Hood, of the Bureau of Mines, presented very convincingly the need for care in selecting coals that involve the minimum of transportation cost. He pointed out to the gas men that the average rail haul for coal used in Illinois, Missouri and Iowa was between one hundred and fifty and two hundred miles. But the rail haul for coal used in gas-making in these states is from four hundred to six hundred miles. The reason for the longer haul is obvious when one considers the necessity of care in selecting gas coal, but the question is properly raised as to the necessity for so great a difference as does exist.

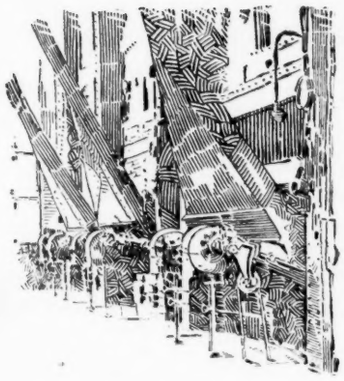
Power-plant engineers should study the same problem as was thus described for the gas man. It is all too easy to fall into the rut of purchasing a particular coal because it is known to work well with the type of stoker and boiler at hand. But indifference to the opportunity of getting coal from near-by sources is not excusable simply because the present supply is good.

Quality of coal is an illusive thing and one hard to define. It means far more than B.t.u. per pound or fusing point of ash. It means, in the last analysis, general performance satisfaction. But in this term of satisfaction there is an element of cost, and long rail hauls are the surest route to high cost. There is no way to beat the railroad game and get coal from long distances without paying correspondingly high freight rates.

The intricacy of coal supply cannot be eliminated all at once, but cross-hauls and over-hauls due to selection of coals from sources unnecessarily far away, can and should be eliminated. The immediate result to the individual plant operator may not be any large advantage, but it will eventually mean greater certainty of supply, lower average costs and equally good plant performance if good sense and good engineering guide in the study which this eminent engineer proposes.



Practical Ideas *from* Practical Men



Preventing Explosions of Air-Compressor Receivers

On discussion of air-compressor installations with persons in our plant we arrived at the following conclusions:

We cannot reconcile ourselves to the idea that a container 20 in. in diameter, for withstanding 100 lb. pressure, should be made of material only ¼ in. thick. Even though the factor of safety of such gage material might be sufficiently high when new, rapidity of reduction of the factor by reason of deterioration is excessively disproportionate to that of heavier gage material.

Where receiver heads are welded to the shell, they usually are flanged and are inserted in the shell. In making the weld of plates so joined, such fusion of material as does occur does not extend far beyond the edge. Electric welding should not be resorted to where the material is to be subjected to any considerable stress of any kind. With such fusion as does occur, there is a joining with material having low tensile strength; also the structure of the material in the parts so joined is changed by heat to such extent as to weaken its resistance to rupture.

Nothing but boiler-plate material, subjected to the rigid tests applied to material for making boilers, should be used in receivers for holding compressed air. The factor of safety should be high enough to withstand the force exerted by an explosion of gas where the conditions are the most extreme that probably could be encountered. For example, for holding at 100 lb. pressure the factor of safety should be not less than 5. The fact that tank plate is a material that is not required to stand the inspection requirements imposed on boiler plate, and therefore costs much less, leads us to think tank plates are sometimes used for making air receivers.

It is only within late years that the theory of gas forming from lubricants that collect in receivers and igniting from heat that is generating by compressing the air, has been advanced. Without questioning the correctness and applicability of the theory, to generate sufficient heat to cause ignition there would need to be fault with the compressor, in the way of leaky valves, that would permit of accumulation of heat in the volume of air delivered to the receiver. Theoretically, not above 240 deg. F., could be generated, while practically it would not exceed 210 deg. with ordinary good conditions, without passing through a cooler, if a constant pressure of 100 lb. were maintained.

Since we must accept the gas-explosion theory, it seems as if it was time to standardize on methods of construction that would reduce to a minimum the liability for explosions to occur. There seems to be no standard method for piping receivers. With some the air is admitted and discharged from the top; with others, at points below the top yet with pocket space above and below the outlet and inlet, which is the most common method and both have the same fault. One purpose of a receiver is to maintain a nearly constant pressure, another is to permit the air to linger while the vapor it contains may condense and deposit at the bottom. Provision is made for draining the water and oil at the bottom, and sometimes further provision is made by trapping at some point in the distributing lines.

In discussion we must point to possible conditions which are not presumed to be constant. Gas generated from the oil may be lighter or heavier than air. This is dependent on its composition, and either condition can exist with gas generated from one kind of oil. Where the air inlet and outlet are located at points below the top and above the bottom, we will say with both on the same horizontal plane, there may be light gas in the pocket above and heavy gas in the pocket below, then an explosion could occur with one or the other or both. This condition probably could be avoided to a large extent, possibly wholly, by placing the inlet pipe near the bottom with just enough room below to hold condensed vapors, and placing the outlet at the extreme top. This would permit of a free flow of all contents, and none that is combustible could linger long enough to accumulate in quantity sufficient to ignite. Although receivers might be piped so that an explosion would not be probable or likely, they should be constructed with a factor of safety high enough to resist explosions.

The foregoing suggestions are intended to apply to such equipment as has been installed without regard to application of present-day methods for securing high efficiency, though the suggestions that apply to piping receivers and strength of material, should apply in all cases.

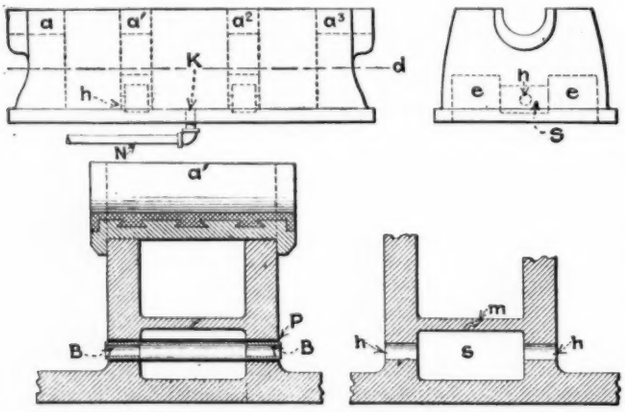
In some cases matters that seem to be trifling in importance are neglected when installing and operating compressor plants. It is good practice to install coolers in connection with compressors, and for large compressors supplied with a cooler between high- and low-pressure cylinders, an additional cooler made of small piping with large area of exposed surface is desirable. There should be a relief valve to each receiver and each compressor. Shutoff valves should never be installed so that they can be operated to prevent a compressor from discharging through a relief valve. There should be a drain valve at the bottom of any receiver and on each cooler.

In operating it is important to see that valves in the compressor do not leak and that they are in good order. Cylinder lubricants should stand high flash tests, say above 400 deg. F., and the amount used should be limited to actual requirements. A compressor for delivering 250 cu.ft. per min. at 100-lb. pressure, should not require more than one quart of lubricant for 24 hours' continuous operation. Always, before starting a compressor after a shutdown period, in addition to draining the fluid collections from the bottom of the receiver, all other contents should be expelled before pressure is permitted to accumulate. It has been found that in some cases the liability of explosion is greater where the contents are not entirely expelled.

WALTER GREENWOOD, Safety Engineer,
Youngstown, Ohio. Carnegie Steel Co.

How Oil Leak Through Sand Hole in Crankcase Was Stopped

Some time ago we experienced trouble with oil leaking through a sand hole in the crankcase of a 400-hp. vertical engine on which the oil was supplied to the guides and bearings by an independent pump. The oil was drained from the crankcase of the engine and carried back to a filter through the pipe *N*, but in spite of the fact that the return was made with 2½-in. pipe, the oil would not return to the filter and storage tank



A PIECE OF PIPE WAS PUT THROUGH THE BEARING SUPPORT

as rapidly as it was pumped to the engine. Also, at frequent intervals oil would leak from the crankcase and flow over the end of the foundation in considerable quantities.

The oil pump was fitted with an automatic regulator and the pressure was normally held at 20 lb. An attempt was made to overcome the trouble by lowering the pressure to 12 lb., and this reduced the leakage slightly. The crankcase had been carefully examined, but no leak was visible. At last the outlet pipe was plugged up and the crankcase pumped full of water. When the water rose up to the height of the dotted line *d*, it flowed out over the foundation as the oil had done. From this it was evident that the oil accumulated in the case up to this level and then ran to waste through some invisible outlet. As it was not intended to keep oil in the crankcase, since the engine was oiled by a pressure system, the first thing done was to determine the cause for the oil not draining properly.

The drain pipe *N*, connected to a 3-in. vertical header into which were connected five other drains. From the bottom of the vertical header the line ran horizontally for some distance to the filter. It was apparent that the oil was being fed to the return header from the several engines, faster than it was being carried to the filter, and this caused it to build up in the crankcase. The first thing done was to change the layout of the return lines so that the engines would be effectively drained at all times. While this change was being made another search was made for the leak in the crankcase, this time with a wire through the holes *h*, which allowed the oil to flow under the bearings, to the center outlet *K*. The supports for the bearings are cast in the base and are hollow on the under side at *e-e* as shown, with a connecting piece, cored out at *S*. A sand hole was finally discovered in the cast tube at the point *m*, shown in the sectional detail. This allowed the oil to flow out through openings in the bed plate and over the foundation.

To stop this leak, the holes *h* were reamed out and a piece of 1¼-in. pipe *P* was annealed and cut the right length to go clear through the webs. Then the nipples *B* were made with a slight taper and were drawn up sufficiently to expand the end of the pipe and make a tight joint by using a draw bolt, through the pipe. The engine was again put in service, and no further trouble was experienced with the oil supply. R. A. CULTRA.

Cambridge, Mass.

Power-Plant Replacements

Recently, when visiting a brother superintendent, I was somewhat amused at the labels upon two drawers of his file cabinet. These were marked respectively, "The Firms Who Do" and "The Firms Who Don't."

In looking through these, I was surprised at the number of reputable firms in the latter category, and, as I have had similar experiences, one can only conclude that there are many firms who, when it comes to replacements to their products, have a champion excuse maker on tap until the firm can get a move on without any undue excitement.

In one case my friend had ordered some castings for a stoker upon a delivery date of fourteen days. Three weeks later he wrote about them and received a reply that the delay was due to a strike, and that they were doing all possible to give delivery. My friend knew this strike was settled in ten days, but waited another three weeks, then wrote again, bringing forth a reply that the castings were causing trouble in annealing, but they hoped to ship in three or four days. However, delivery was not made until some weeks later.

This case is only one of many in his pile of "Firms Who Don't." Many of us know that considerable expense is entailed if a firm keeps a replacement of everything it makes ready for immediate dispatch, but it should not be impossible to stock the parts subject to wear and breakage, as prompt delivery is a valuable asset, while the reverse may have serious effects. A good method, where stocking of replacements is not practicable, would be to advise users to have these replacements ordered in good time or in advance.

Many firms do realize that although their products are the best in the market, neglect of the fact that they must keep their customers satisfied would ruin their good will, and it is to be regretted that more firms do not put forth better efforts to keep away from the list of "Firms Who Don't." F. P. TERRY.

Belfast, Ireland.

Comments from Readers

Catalogs and Advertising for the Boys

In reading E. W. Brong's article entitled "Catalogs and Advertising for the Boys," in the Oct. 9 issue, the thought came to me, How about helping these boys at the other extreme of life if they should need help?

I most heartily endorse all Mr. Brong has said about "sowing seeds in good ground that will bear fruit tenfold," and I am most thankful for the kind and encouraging words said to me by the prominent engineers I met in my youth when health, strength and will to climb were at my command; but as the years have gone by, I have met many who have lost the competency they had provided for possible old age, through no fault of their own, and I know quite a number of members in good standing in the A.S.M.E. who are in that unfortunate condition—men who have well done their bit in advancing the "arts and sciences connected with engineering and mechanical construction," men who were shining lights in their profession at middle age, but who now at advanced age are helpless—and the question presents itself, Are these not worthy of some consideration? They have materially helped to build up the great institutions of our country, but they were not financiers. In fact, with the exception of the late George H. Corliss I cannot recall a corporal's guard who was a high-grade engineer and at the same time a financier.

W. H. ODELL.

Brooklyn, N. Y.

Babbitting Oil Engine Pistons

In an article on steam-engine operation and maintenance, appearing in *Power* some time ago, H. Hamkens referred to the bad results of babbitt in steam-engine pistons. However, the application of this metal to oil-engine pistons has been successful, inasmuch as the Werkspoor Company, of Amsterdam,

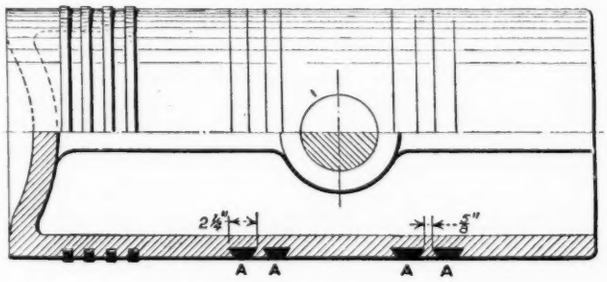


FIG. 1—BABBITT RINGS ON DIESEL PISTON

Holland, face the trunk pistons of their small and medium-powered Diesel engines with four babbitt rings. These rings are turned flush with the face of the piston and are of the form shown in Fig. 1.

As to the construction of oil and gas-engine packing rings, I prefer a common bull joint. These rings can be kept from rotating by short pins or dowels that correspond with holes drilled in the rings, as indicated in Fig. 2.

In one case the piston head of a vertical Diesel was cracked and a new piston furnished by the makers. This second piston made no better showing. The makers drilled a hole in the center of the head of the

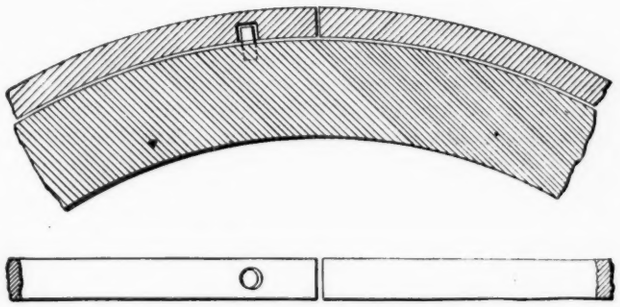


FIG. 2—PREVENTING PISTON RINGS FROM ROTATING

third piston and after inserting a steel plug, made a tight job by welding. Perhaps it is mere chance, but this piston has outlived its predecessors.

Schoonhoven, Holland. H. WEILAND LOS.

Early Corliss Pumping Engine

After reading Mr. Odell's letter in the Oct. 2 issue I recall some facts about the early pumping engines built by George H. Corliss. In 1878 Mr. Corliss built a pumping engine for what is now the City of Pawtucket, R. I., which was a marvel for economy in its day and a long time afterward. This engine was rather novel in design. It was a horizontal cross-compound, with water cylinders in line with the steam cylinders, and what would be connecting rods on a standard engine connected to vertical levers pivoted below the floor. The top ends of these levers had connecting rods that worked the crankshaft and flywheel which were mounted on the top of the air chambers of the pumps. The flywheel was all above the engine-room floor. The upper ends of the levers had a throw twice the length of the piston stroke. When the engine was running with these great levers whipping back and forth and the shaft eight or nine feet above the floor, it looked novel to say the least.

The engine Mr. Odell speaks of, was a vertical cross-compound beam engine. For some reason it was rejected by the City of Boston and a Leavett engine installed in its place. Mr. Corliss then set it up in his yard and ran a duty test on it, after which it was sold to the City of Providence and installed at the main station on the Pawtuxet River. I have no figures of the duty, but it was common talk at the time that both of these pumps were the equal of anything built up to that time.

Mr. Corliss was not only a great designer, but a great business man as well. After the panic of 1873 all industry in Providence was paralyzed for a long time, and during the worst of it Mr. Corliss built the Centennial

Engine, which was one of the greatest advertisements a man could have, and with it he obtained a contract to furnish the power for Machinery Hall, which was very profitable. He also got contracts for these pumping engines and some other work, which kept his shop running more than others in the town. This gave employment to a good many Providence men, who were in sore need of it at that time. W. E. HOPKINS.

Torrington, Conn.

Factors That Affect the Life of Iron Stacks

I would like to add a few comments to the discussion that has already taken place (in the Aug. 28 and Oct. 9 issues) on the subject, "Factors That Affect the Life of Iron Stacks."

In the extensive lumber industry of the North Pacific Coast, where green mill refuse is practically the only fuel used, we find that the corrosive action takes place from the inside of the stack rather than the outside. The plan shown by Mr. Duffey, of blocking the guy ring away from the stack, is a good one. It has been my experience, however, that long before any combination of ash and water has affected the stack from the outside to any extent, the top sections are corroded through, from the action of the gases on the interior of the stack.

Our trouble here is that the acids natural to the woods we burn are distilled and pass from the furnace in gaseous form, and upon reaching a certain temperature in the upper sections of the stack they condense and gather on the inside of the plate.

All the water content of the gases passes out of the stack as steam without doing any harm, but the acids condense at a fairly low point in the stack, particularly at low temperatures.

No paint or coating that we can find will resist this attack from the inside, and the average iron stack needs renewing from about 25 feet above the boiler to the top every few years. R. MANLY ORR.

Vancouver, B. C., Canada.

Strength of Used Elevator Cables

I read with much interest the article by C. W. Willits on "Strength of Used Elevator Cables," in the Sept. 18 issue, and it is so well done that I hesitate about criticizing it or offering any suggestions. Still, it would be interesting if a reason had been given for the cables with minimum strength breaking at the socket, as mentioned on page 454, column one, near the bottom. Again on the same page, column two, the condemned cables which break after a few day's service on a 12-in. sheave, do not prove anything because no one would run a $\frac{5}{8}$-in. cable over a 12-in. sheave with the 1,500-lb. load unless he expected it to break. The same rope would probably have lasted several months with a 1,000-lb. load over an 18-in. sheave, with not many bends per mile.

It would have been interesting if the author had told us, to know, when renewing a set of six cables, whether in all cases they were equally worn or whether one or two cables alone determined the time of changing for the whole set.

The accompanying table shows the mileage of three kinds of rope on eight high-speed one-to-one traction machines installed in June, 1914. The table, with attached notations, is self-explanatory. It is too bad that it takes so long to come to any conclusion as to the life and service of elevator ropes. It is practically a lifetime job to obtain any definite results.

TABLE I—MILEAGE ATTAINED BY ELEVATORS WHEN CABLES WERE RENEWED JUNE 25, 1914 TO SEPT. 25, 1923

Car No.	1st Cable	2d Cable	3rd Cable	4th Cable	5th Cable	Cable Now in Use
*Traction Ropes**						
81	21,400	24,500	13,000	.....	.....	12,380
82	28,600	6,750	.....	.....	.....	21,840
83	35,300	12,400	.....	.....	.....	10,360
84	22,000	.....	.....	.....	.....	37,200
85	36,200	11,400	.....	.....	.....	10,300
86	49,800	.....	.....	.....	.....	7,280
87	36,200	13,000	.....	.....	.....	7,280
88	35,300	.....	.....	.....	.....	21,840
Compensating Ropes†						
81	16,200	30,600	8,400	.....	.....	16,200
82	13,000	16,100	13,600	14,300	.....	1,300
83	13,000	13,000	30,000	.....	.....	1,300
84	13,000	19,600	.....	.....	.....	27,000
85	13,000	15,600	19,600	.....	.....	8,700
86	13,000	3,100	14,300	18,100	.....	8,700
87	14,500	2,600	13,600	18,100	.....	8,700
88	14,500	2,100	11,400	.....	.....	29,500
Governor Ropes‡						
81	7,800	5,800	32,500	(*a*) 63,000	.....	25,000 (*a*) 8,400
82	7,800	2,100	31,200	(*a*) 26,000	.....	16,000 (*a*) 31,000
83	6,750	(*a*) 7,250	(*a*) 33,300	.....	.....	51,000 (*a*) 16,500
84	7,800	(*a*) 8,300	(*a*) 48,400	.....	.....	49,500 (*a*) 700
85	8,800	(*a*) 1,150	.....	.....	.....	48,500 (*a*) 56,000
86	7,800	2,100	35,100	(*a*) 25,400	(*a*) 15,000	12,000 (*a*) 16,500
87	14,300	1,600	40,100	(*a*) 56,100	.....	700 (*a*) 700
88	14,800	35,100	(*a*) 20,800	.....	.....	6,700 (*a*) 36,000

* Traction ropes six $\frac{3}{4}$-in. running on 33- and 36-in. drums. Car No. 81 averages 650 miles per month. Cars 82 and 88 average 520 miles per month, 600 ft. speed, 55 bends per mile of travel.

†Compensating ropes five $\frac{1}{2}$-in. running on 24-in. sheaves, 19 bends per mile of travel.

‡ Governor ropes $\frac{1}{2}$-in. running on 18-in. sheaves, one rope on car governor and one rope marked (*a*) on counterweight governor, 19 bends per mile. Tiller rope used prior to 1920. Since 1920, $\frac{1}{2}$-in. iron ropes used.

C. W. NAYLOR, Chief Engineer.

Chicago, Ill. Marshall Field & Co.

More Information Necessary for Best Results with Underfeed Stokers

A recent article in *Power* was a pertinent reminder of the fact that there is really little material available regarding the theoretical conditions obtaining on the surface of an underfeed stoker, also very little regarding simple specific rules for their operation.

I am in close touch with underfeed stoker operation and fully realize this condition. In my opinion underfeed stokers have great possibilities, but in many cases the best results are not being obtained.

The accompanying illustration shows the outline of a stoker with the underfeed and overfeed sections indicated. From experience with underfeed stokers a number of questions have come up from time to time, and I should like to place these before the readers of *Power* with the hope of getting some enlightenment. The questions are as follows:

1. What are the conditions prevailing at regions *A*, *B*, *C*, *D*, during normal operation of the stoker with respect to: (a) The fuel analysis in per cent of volatile, fixed carbon and ash; (b) the combustion of the fuel, fixed carbon and volatile at bottom of bed center and surface; (c) fraction of total combustible burned in each region; (d) extent of "producer action" obtaining; (e) the most desirable thickness of bed.

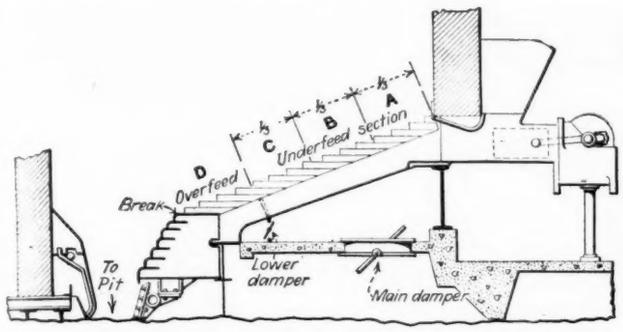
2. What is the effect of variation in the fineness of the coal?

3. What causes the ash to move over the break in a friable condition at times and to form large clinkers at other times?

4. What causes clinkers to form in the pit?

5. In general how are conditions (a) to (e) affected by operation at low, moderate and high ratings?

Possibly some readers who thoroughly understand the theory of combustion as it applies to underfeed stokers



GENERAL VIEW OF UNDERFEED STOKER

can give us a complete analysis. We may then be better able to decide on the proper wind pressure, depth of fuel bed, and other variables incident to stoker operation. G. A. MARSH.

Boston, Mass.

Air Compressor Got Red Hot

Being the contributor of the article, "Air Compressor Got Red Hot," in the Aug. 14 issue, I should have pointed out particularly, the fact that the valves on this compressor were not leaking at the time the trouble occurred, neither was any work done on the compressor afterward, except to clean out thoroughly the high-pressure cylinder. According to the theory of J. M. Franklin in the Sept. 18 issue, had the discharge valves been leaking it would have been only a question of time before the ignition point of the oil would have been reached again and the pipe have become red hot. However, we have not had the same trouble since. The machine has had leaky valves at times and has not given trouble, and I have never found any carbon on the valve seats.

This brings up a point that is open for discussion: Could leaky valves cause sufficient increase in temperature to make the pipe line red hot? I must frankly admit that I cannot see it, so I should appreciate a little enlightenment on this point, which undoubtedly is of considerable interest to other readers. A. H. LACEY.

Selkirk, Man., Canada.

Feeding Boilers with Partly Closed Feed Valves

Referring to the article by A. L. Harris entitled "Does a Partly Closed Feed Valve Increase the Duty on the Feed Pump?" in the Sept. 18 issue, I agree with him that the amount of work done by the feed pump is increased the more he closes the discharge valve on the boiler. This is proved by the fact that the feed pump will slow down considerably if the discharge valve is throttled down without increasing the steam supply.

My experience, however, has been that there is no additional vibration noticeable in the pipe line owing to this increased pressure.

If Mr. Harris wants to know definitely the discharge pressure on his pump, I would suggest that he put a pressure gage in the feed line. He will then prove to his own satisfaction how much excess pressure over boiler pressure he is obtaining by partly closing the feed valves. I see no reason or advantage for partly closing a discharge valve on a boiler-feed line unless there is an air chamber installed on the line to eliminate pulsations of the pumps in connection with a feed-water meter.

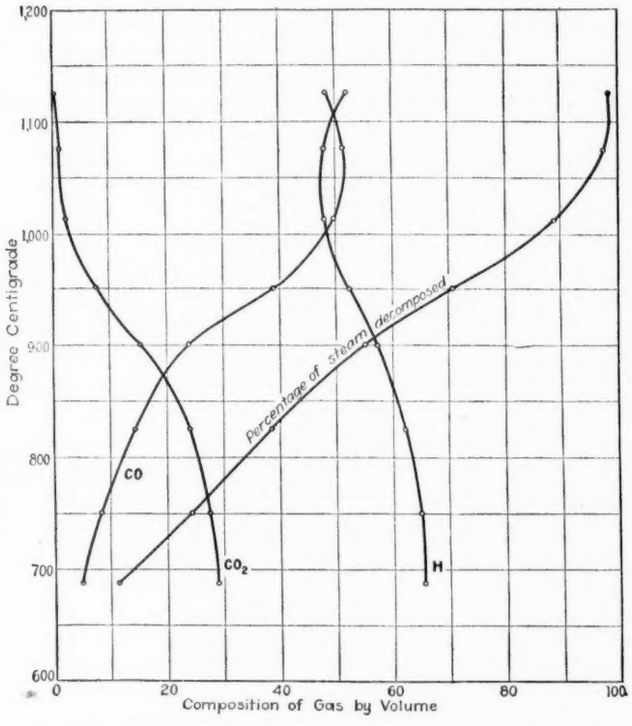
There are some makes of automatic feed-water regulators that require an excess pressure of ten to fifteen pounds over the boiler pressure in order to work properly. In this case excess pressure is justifiable; otherwise it is not.

The vibration in the feed line which Mr. Harris mentions may be caused by the steam backing down from the boiler through the feed pipe. This is particularly likely to occur when the pump is operating slowly. This trouble could be overcome by installing a check valve in the feed line near the boiler.

South River, N. J. J. LIMBRUNNER.

What Happens to Moisture When It Enters the Furnace?

Referring to the article, "What Happens to Moisture When It Enters the Furnace?" in the Sept. 18 issue, the chart shown herewith may be of interest. I obtained this chart some years ago when experimenting



PERCENTAGE OF STEAM DECOMPOSED AT VARIOUS TEMPERATURES

with fixation temperatures of gas producers; the precautions adopted would prevent any large error in the readings. The steam was passed through a bed of charcoal and practically perfect contact between carbon and steam secured. Opinion seems to vary greatly on this subject, and I should like to see further discussion in *Power*. JAMES F. EDGELL.

Malden, Essex, England.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Injuries from Excessive Calking

What injurious effects may result from excessive calking of boiler seams? A. A. H.

In driving back the calking edge to tightness, the upper plate is severely sprung up, and excessive calking may injure the overlapping plate with distortion of the rivets. Very frequently, excessive calking injures the lower plate by battering it down, or the careless use of calking tools with sharp corners cuts into the lower plate sufficiently to cause injury.

Adapting Grate Area to Boiler Load

We have a water-tube boiler with 3,500 sq.ft. of heating surface, but the maximum output is only about two-thirds capacity. The furnace is hand-fired with shaking grates, and there is about 10 ft. clearance between the grates and tubes. The flue-gas analyses average 10.6 per cent, but at each firing we have considerable smoke. With alternate firing there is 2 to 3 per cent less CO_2. The grates are in eight sections. Would it not be advantageous to brick over two of the sections to cut down the grate area to correspond with the load? J. F. J.

Assuming that the present grate area is proper for full capacity, reduction of grate area as proposed should result in greater activity of combustion with higher temperature of the fuel bed, better combustion and less smoke, provided the stoking is uniform with about three-fourths the present intervals between times of firing.

Disposal of Chimney Soot

In large steam plants is it customary to let the chimneys take care of the soot, or are the chimney bases frequently cleaned? N. N. H.

Properly constructed chimneys are provided with means for removing deposits of soot and cinders gathered at the base of the flue, and the frequency required for cleaning depends on the character of fuel, nature of combustion and force of draft. Many larger plants are provided with chutes for discharging soot and cinder thus gathered. However, the frequency of cleaning out the base has little effect on the amount of soot discharged from the top of a stack, and in almost all plants a much larger quantity of soot is discharged in the smoke than there is deposited in the chimney, although the chimneys are not especially designed for the purpose. On the other hand, special appliances have been installed in a number of instances to collect as much of the soot and cinder as possible, to prevent the nuisance caused by their discharge to the atmosphere.

Suction Pressures in an Ice Plant

How can the back pressure be raised when first starting a motor-driven ammonia refrigerating plant if it is low, say zero lb., and it is desired to bring it up to about 5 lb. without frosting the compressor or freezing it up? F. A. E.

The back pressure that it is possible to carry, say in evaporating coils, depends on the amount of heat taken up per square foot of coil surface and this, in turn, depends on the temperature of the brine. If there is not much ammonia in the coils, the amount of ammonia evaporated will be less if the amount of square feet of coil surface in contact when the liquid ammonia is low. This ammonia, after being evaporated, will fill the space in the pipes above the surface of the liquid and will pick up some heat and become superheated as it passes along the pipes to the compressor.

The amount of superheat that it takes up is limited by the temperature at which the brine is being carried. If there is not much ammonia in the coils and the compressor runs at a constant speed, the vapor will be taken out as fast as it is made and the pressure will drop. On the other hand, if the compressor is slowed down so that it takes off the ammonia vapor a little slower than it is being generated, the tendency is for the pressure to go up a little until the amount of heat that will pass through the pipe at the temperature difference between the brine and the ammonia just equals the amount of heat taken up by the vapor going to the compressor. If there is ample coil surface, it is possible to open the expansion valve and have the coils entirely filled with ammonia, and then the gas going to the compressor will be saturated and at a temperature corresponding to the pressure in the coils. The pressure will ordinarily be slightly higher than it will be with the coils but partly filled. However, if the amount of coil surface is insufficient, the displacement of the compressor will be more than the volume of the gas evaporated in the coils, and there will be a tendency for the ammonia liquid to be pulled over to the compressor, and the compressor in that case will freeze up. It is necessary, for the proper operation of the plant, in case the compressor is operating at a uniform speed, to cut back on the expansion valve so that the suction line to the compressor is not frosted clear up to the compressor valve cage. Consequently, the pressure in the coils must be what is well under the given conditions of coils surface and the brine temperature carried. All that can be done is to so regulate the expansion valve that the machine is not frosted up. While a high suction pressure is desirable, this cannot be entirely controlled for it largely depends on the amount of coil surface per ton of ice carried.

Discharge of Rotary Pumps

What quantity of water is raised 80 ft. by a rotary pump with 2-in. suction driven by a 5-hp. motor.
E. D. M.

It is impossible to estimate the quantity of water discharged from a mere statement of the capacity of the motor and size of pump suction. Undoubtedly, the motor is called upon to develop less than its rated capacity, and to estimate the amount of water discharged, it would be necessary to know the current taken by the motor and its efficiency with the given electrical input, and also the efficiency of the pump when running at the speed under consideration. A rough estimate can be made from the manufacturer's rating. Rotary pumps with 2-in. suction usually are made to discharge about 50 gal. of water per minute running 200 r.p.m., or $\frac{1}{4}$ gal. per revolution.

Size of Reducing Valve

Where a pressure-reducing valve is used for regulation of the amount of high-pressure steam required to be delivered by a smaller pipe to maintain a reduced pressure in a larger pipe, should the size of reducing valve be the same as the larger or the smaller pipe?
F. S.

The reducing valve should be no larger than necessary to deliver the maximum quantity of high-pressure steam required with the valve wide open, and therefore should not be larger than the discharge capacity of the smaller pipe. A reducing valve seldom is required to deliver the maximum discharging capacity of the high-pressure supply line, and the "wiredrawing," from having the valve "cracked" most of the time is accompanied by cutting of the valve and seat. The greater the full open capacity of the valve in excess of the requirement, the less the lift of the valve from its seat and the greater the damage from wiredrawing of the steam.

Lap Cracks and Bags in H.R.T. Boilers

In a horizontal return-tubular boiler, what is a lap crack, where does it occur, and what causes such a crack? Also, where is a bag most likely to occur and what are its causes, and how remedied? R. K. H.

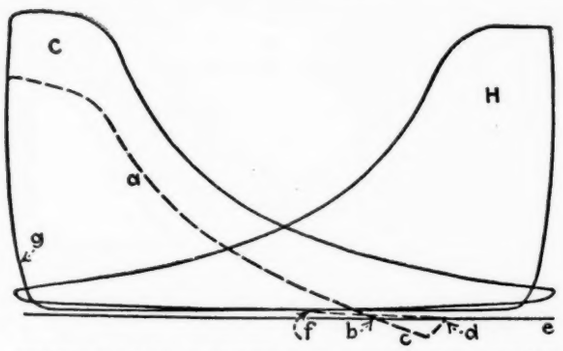
A lap crack is a fracture along either of the plates of a riveted joint, due to bending of the plates from the tendency of the stresses to draw the material into the line of action of the stresses. In a horizontal return-tubular boiler the steam pressure tends to bring the points of tangential resistance into the form of a circle. In ordinary lap joints for longitudinal seams this results in severe bending stresses at the joints, and the breathing action with variations of steam pressure frequently results in the cracking of a plate near the edge of the overlapping plate. Such cracks may occur where they are hidden by the overlapping of the plates and thus are more dangerous, as their existence is difficult to discover by ordinary inspection of the joints.

A bag, or permanent local bulge of a boiler from internal pressure, is most likely to occur in the under side of the shell, from becoming overheated by exposure to direct radiation of heat of the fire or impingement of the hottest gases. Overheating occurs when the heating surfaces are not kept cool by direct contact with water in the boiler, and the overheating that results in bagging generally is caused by the presence of oil or scale in the bottom of the boiler. Hence the precaution against bagging is to keep the interior of the boiler as clean as possible. A small bag usually can be heated and the plate pounded back, but when that is not practical, the bagged portion of the sheet must be cut out and replaced by a patch, placed on the inside of the boiler so no pocket will be formed for holding oil, mud or scale.

Noisy Exhaust Valve from Expanding Below Back Pressure

Some time ago the gasket blew out of the bonnet of the crank-end exhaust valve of our 28½x60-in. simple Corliss engine. Since recently renewing this gasket, there is a slapping noise in the valve while the engine is turned over slowly 10 or 15 minutes for warming up before laying on the load, but the noise ceases again after the regular load illustrated by the diagrams comes on the engine. What causes the noise and how can it be prevented? J. N. F.

During warming up of the engine, while underloaded, the cutoff is so short that expansion of the steam goes below the pressure of the atmosphere. If an indicator



BROKEN LINE ILLUSTRATES EXPANSION BELOW ATMOSPHERE

diagram were taken, it undoubtedly would be of the general form shown by the broken lines *a b c d e f g*, with the expansion line falling below the atmosphere line as at *b*. At *c* the pressure becomes low enough for the valve to be forced from its seat by air or other back pressure, and the valve is thus held while the piston moves from *d* to *e*. On the return stroke, the valve returns to its seat and usually with less noise, as the pressure within the cylinder is gradually increased by the piston pushing the exhaust out of the cylinder.

If no slapping noise took place while the imperfect gasket was in use, it was because expansion could not go far enough below the pressure of the atmosphere for the valve to become unseated on account of air being drawn into the cylinder from leakage of the gasket or from some other source. When an engine is thus underloaded, the remedy is to supply it with steam so much reduced in pressure, as by throttling, that the points of cutoff will not result in expansion below the back pressure. While the engine is temporarily underloaded, expansion below the atmosphere can be prevented by deliberately creating an air leakage into the cylinder, as by leaving the indicator cocks slightly open to the atmosphere.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

Easy Lessons in Engineering

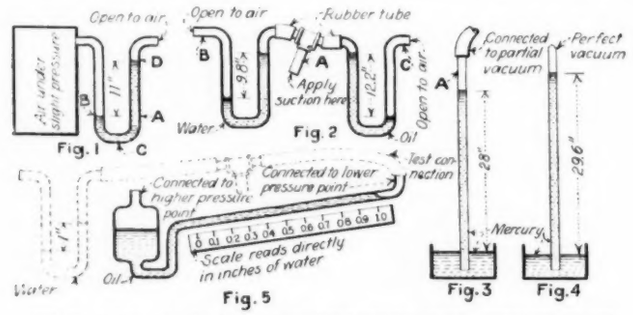
How a Manometer Works

A manometer is any instrument that measures pressure differences (usually small) by the position of a liquid in two arms of a tube. Typical examples in power-plant practise are draft gages, barometers, vacuum columns and absolute-pressure gages. To understand the action of a manometer, it is important to know the law that the pressure per square inch at any depth below the surface of a liquid at rest is equal to the pressure at the surface plus the weight of a cylinder of the given liquid having a cross-sectional area of one square inch and a height equal to the vertical depth of the point considered below the surface of the liquid. The following data will be convenient in a further discussion of manometers.

DATA ON MANOMETER LIQUIDS

Liquid	Weight of One Cu.In., Lb.	Pressure, Lb. per Sq.In. for Each Inch Submergence
Water	0.036	0.036
Mercury	0.49	0.49
Typical kerosene	0.028	0.028

Referring to the table, we see that the weight of one cubic inch of water is 0.036 lb., so the pressure at one inch submergence must be 0.036 lb. per sq.in. more than the pressure on the surface. Consider Fig. 1, which



FIGS. 1 TO 5—DIAGRAMS SHOWING THE PRINCIPLES OF MANOMETERS

Fig. 1—Simple U-tube manometer. Fig. 2—Checking oil against water. Fig. 3—Vacuum column. Fig. 4—Barometer. Fig. 5—Inclined-tube draft gage.

shows a U-tube of water with one end connected to the delivery duct of a fan and the other left open to the air. The pressure at *A* must equal that at *B*. To see this, start at *B* and move down to *C*. The pressure will increase by an amount corresponding to the vertical distance from *B* to *C*. Then move up to *A* and the pressure will decrease again by exactly the same amount, leaving the pressure at *A* equal to that at *B*. But *A* is 11 in. below the surface of the water in the right leg, so the pressure at *D* must be less than that at *A* or *B* by an amount equivalent to 11-in. head of water, or $0.036 \times 11 = 0.396$ lb. per sq. in. That is, the pressure at *B* must be 0.396 lb. per sq.in. more than that of the atmosphere pressing on *D*.

A cubic inch of mercury weighs 0.49 lb. (13.6 times as much as water), so if the liquid used in Fig. 1 were mercury, the pressure (above atmosphere) would be 11 in. of mercury or $11 \times 0.49 = 5.39$ lb. per sq.in. Roughly speaking, 1 lb. per sq.in. equals 2 inches of mercury and 28 in. of water.

Again, if the tube in Fig. 1 were filled with kerosene of the weight shown in the table, the pressure would be $0.028 \times 11 = 0.308$ lb. per sq.in. If an oil of unknown weight is to be used, it may easily be checked against water by using two U-tubes, as shown in Fig. 2.

The density of kerosene varies considerably, so the figure given in the table is only for illustration.

Here each column measures the same pressure difference, namely, the difference between the pressure in *A* and that of the atmosphere at *B* and *C*. If 12.2 in. of oil is found to balance 9.8 in. of water, each inch of oil must be equal to $9.8 \div 12.2 = 0.804$ in. of water, or $0.804 \times 0.036 = 0.0289$ lb. per square inch.

Likewise, each inch of water equals $12.2 \div 9.8 = 1\frac{1}{4}$-in. of oil, so a special scale with $1\frac{1}{4}$-in. spaces marked as even inches would read inches of water directly when applied to the oil manometer.

Two common forms of mercury manometer are the vacuum column and the barometer, shown in Figs. 3 and 4 respectively. In both the well forms one leg and the tube the other, the vertical distance between the two mercury surfaces representing the vacuum in the top of the tube; that is, the amount the pressure there falls below atmospheric. In the barometer, Fig. 4, the vacuum is perfect (zero pressure), so the height of the column measures atmospheric pressure. If the column in Fig. 3 is 28 in. and that in the barometer is 29.6 in., the difference, 1.6 in., must be the absolute pressure at *A* (Fig. 3). This is equivalent to $30 - 1.6 = 28.4$-in. vacuum on a 30-in. barometer.

Draft pressures are generally too small to measure accurately with mercury columns, so oil or water is ordinarily used. Even then the drafts (at least those above the fire) are too small for convenient readings with vertical tubes. To overcome this difficulty the inclined-tube manometer was developed.

This type of manometer is shown diagrammatically in Fig. 5. Here a long movement along the tube corresponds to a small vertical rise. The use of a lighter liquid than water still further increases the movement for a given pressure drop. The fall of the liquid in the reservoir is slight and is taken care of in graduating the scale. To calibrate such a scale with a one-inch range, first adjust the liquid to a zero near the lower end of the straight tube. Then connect the low-pressure end to one leg of a water manometer as shown in dotted lines. Withdraw air until the water manometer reaches exactly one inch. Mark this point as one inch on the draft-gage scale and divide the space between zero and one inch evenly for tenths and hundredths.

Power of the Western Slope of Southern Appalachian Mountains*

By J. A. SWITZER† and W. R. WOOLRICH‡

A MAP showing the transmission systems of the Southern Appalachian region as built to date, is shown in Fig. 1. In 1905 the nucleus for future growth was planted by the Southern Power Co., which in that year built the first mile of high-tension transmission line in this region. From 1905 to 1912 the system slowly spread over the Piedmont Plateau, or that portion of it occupied by the Southern Power Co.

In 1912 the Watauga Power Co. built 17 miles of transmission line and delivered Watauga River power to the City of Bristol. Within a few days of the opening of this line the Tennessee Power Co. (now the Tennessee Electric Power Co.) began to furnish power to Knoxville and to Chattanooga from the Ocoee River. Later in the year the Georgia Railway and Power Co. opened the turbine gates at Tallulah Falls and the power of the Tallulah River flowed into Atlanta. In 1913 Birmingham began to receive power developed by the Alabama Power Co. at Lock 12, on the Coosa River.

From these centers transmission lines began to radiate, and extensions, ramifications and interconnections have finally knit the Southern Appalachian region into the most extensive 110-kilovolt superpower system existing in the world today—a system with an aggregate mileage exceeding 5,000, which is still growing vigorously and no doubt will continue to grow for some years to come.

The general requirements for power in the territory served by the Tennessee Power Co. are such that the present generating capacity of 168,000 hp. is inadequate to meet the demand. The company is now building two additional steam plants, each of 27,000-hp. capacity, one at Nashville and one at the hydro plant at Hales Bar. The hydro plant at Great Falls is also being enlarged by the addition of a second 12,000-hp. hydraulic turbine.

All over the territory considered in this paper like conditions are seen. Construction of new power plants can scarcely keep pace with the growing demand for more power; and one authority recently remarked that the Southern power companies are today 25 per cent behind the power market requirements. Everywhere intense construction activity is in evidence.

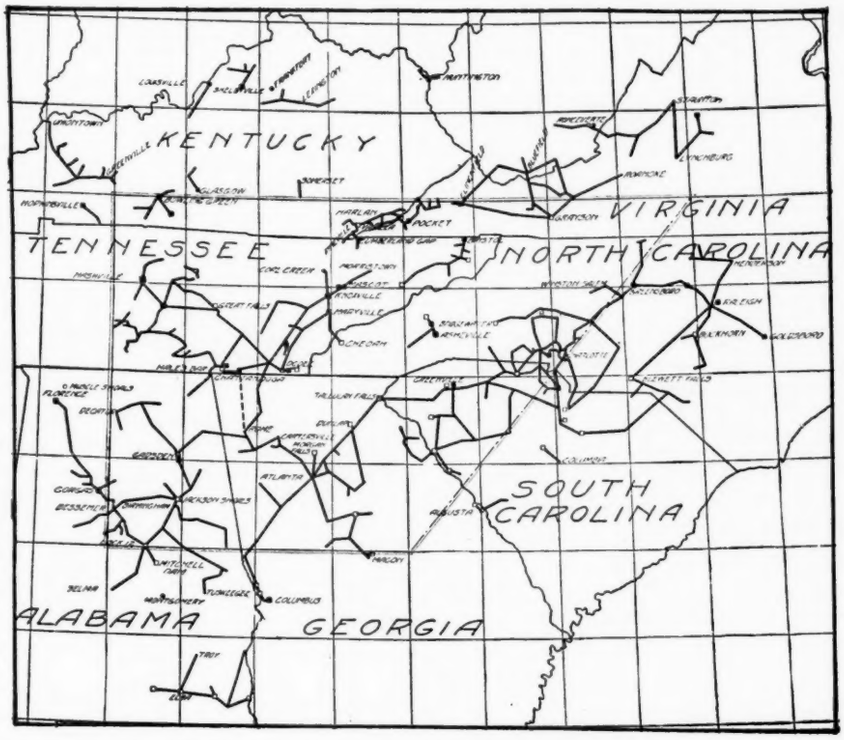


FIG. 1—MAP OF SOUTHERN APPALACHIAN REGION SHOWING TRANSMISSION SYSTEMS THUS FAR BUILT

The Kentucky Utilities Co. is just completing a steam plant at Pineville having a present generating capacity of 40,000 hp. and a future capacity of 60,000, and will shortly start work on a hydro plant on the Dix River.

The Tennessee Eastern Electric Co. is adding to its two units on the Nolichucky River two more, and it will shortly be at work increasing the height of its dam from 35 ft. to 70 ft., thus more than tripling its present hydro generating capacity. It is also building a steam plant of 13,000 hp.

Both the Tennessee Electric Power Co. and the Knoxville Power & Light Co. have filed with the Federal Power Commission applications for permits to make very large developments on the Tennessee River, the Clinch River and the Powell.

With a present generating capacity of 105,600 hp. of hydro and 30,800 of steam power, the Georgia Railway & Power Co. is just finishing construction of an 84,000-hp. plant on the Tugaloo River. In addition to a total generating capacity of 265,400 hp., this company owns 303,000 hp. of undeveloped or partly developed water power.

The Alabama Power Co. is just adding to its present generating capacity of 200,900 hp., 72,000 hp. more at the Mitchell dam on the Coosa River. Permits have been secured from the Federal Power Commission for four dams to be built on the Tallapoosa River, but before building these the company will first build plants to be called Upper Tallassee, Cherokee Bluffs and Lower Tallassee, and will follow these by a plant at Lock 18, below Mitchell dam on the Coosa. Designs for the first three of these are now being worked out.

So heavy has been the demand for power in these several states that for the last two years the Alabama Power Co. has leased the 80,000-hp. steam plant built by the government during the war at the nitrate plant at Sheffield, and this plant has served as an auxiliary to the constituent companies in the superpower system.

The Southern Power Co., with a present generating capacity of approximately 300,000 hp. will this year complete two new hydro plants, one at Mt. Holly, N. C., and one at Great Falls, S. C., which will add another 140,000 hp. In addition to this, construction of two more steam plants with a combined capacity of 60,000 hp. will bring the total generating

*Presented at the Chattanooga Regional Meeting, Southern Local Sections, American Society of Mechanical Engineers, Chattanooga, Tenn., Oct. 23 and 24, 1923.

†Professor of hydraulic and sanitary engineering, University of Tennessee.

‡Associate professor of mechanical engineering, University of Tennessee.

capacity of the Southern Power Co. to about 500,000 hp. The power business in this region increased from about 420,000,000 hp.-hr. in 1914 to 1,500,000,000 hp.-hr. in 1920.

On a certain day not long since, copious rain occurred on the head waters of the Coosa River. The small reservoir of the Alabama Power Co. at Lock 12 on the Coosa River was full, and so could not conserve this flood flow. But the reservoir of the Carolina Power & Light Co., on the Pee Dee River, 650 miles away, had been drawn down, and an

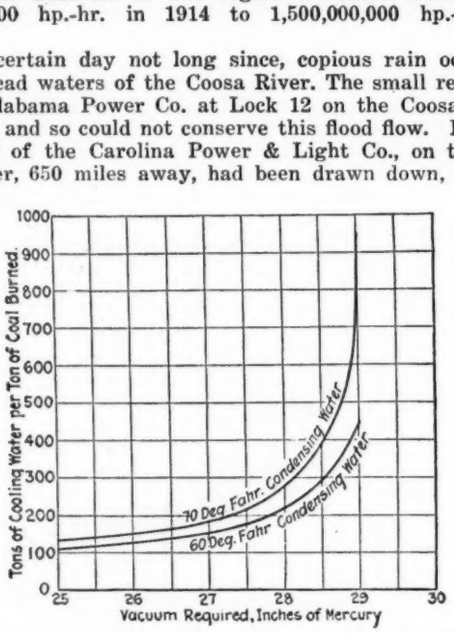


FIG. 2—CONDENSING WATER REQUIREMENTS OF STEAM POWER STATION, BASED ON AN EVAPORATION OF 9 LB. WATER PER LB. COAL

insufficient flow meant a shutting down, or at least curtailing of output, of the many cotton mills in and around Raleigh dependent on this water power. And so for a time the turbine gates at the Blewett Falls plant of the Carolina Power & Light Co. on the Pee Dee River were closed; and while the reservoir was thus allowed to be replenished, the load of the company was carried by power relayed to it by the Southern Power Co., which in turn received it from the Georgia Railway & Power Co., to whom it was delivered by the Alabama Power Co.—power generated by the flood flow of the Coosa River. Here indeed was conservation doing real work!

This incident symbolizes the immense good that can and does come of the interconnection of large transmission sys-

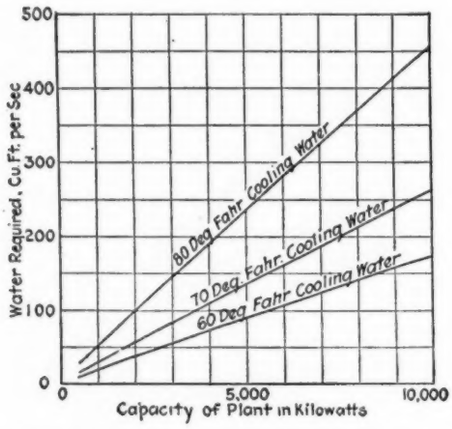


FIG. 3—CONDENSING-WATER REQUIREMENTS OF PLANTS OPERATING AT 28½-IN. VACUUM REFERRED TO SEA LEVEL

tems. Recently, the manager of a large power company said: "Our company had completed the plans for a million-dollar auxiliary steam plant. But our experience since we became interconnected with our power neighbors has retired the plans to a filing cabinet. We believe now we shall not need the steam plant, or at least not in the immediate future."

The installation of base-load steam plants at the coal-mine mouth has constituted an interesting and popular topic of discussion in all coal sections. To the layman it appears that the logical solution for the distribution of all coal-generated power is over the wires. There are several advantages in such a system. It relieves the management of the generating station of the menace of a car shortage. It permits the use of certain low-grade fuels that it otherwise would not pay to use. It saves the freight charge on the

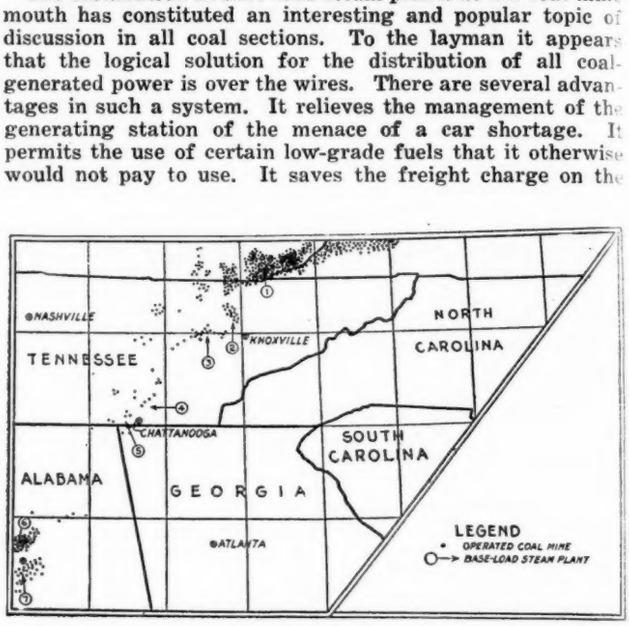


FIG. 4—MAP SHOWING DISTRIBUTION OF OPERATIVE COAL MINES IN THE SOUTHERN APPALACHIAN REGION AND DESIRABLE LOCATION FOR BASE-LOAD STEAM PLANTS

Condensing water available at the different sites is sufficient for a generating capacity of 75,000 to 100,000 kw. at No. 1, Pineville; 400,000 to 450,000 kw. at No. 2, Clinton; 75,000 to 100,000 kw. at No. 3, Harriman; very large at No. 4, Chattanooga; also at No. 5, Hales Bar, and at No. 6, Gorgas; 20,000 at No. 7, Helena.

coal that is used. Other factors enter, however, that are of greater importance than those just mentioned. The most important one is the availability of adequate condensing water. Second only to this must be security of the coal supply—some form of anti-coal-strike insurance.

These two factors are of such predominating importance that to meet the requirements of a successful base-load station at the coal-mine mouth, it must be located on a river which will give sufficient minimum flow to meet all condensing requirements, and that it must be sufficiently near a transportation system to put it in immediate haulage con-

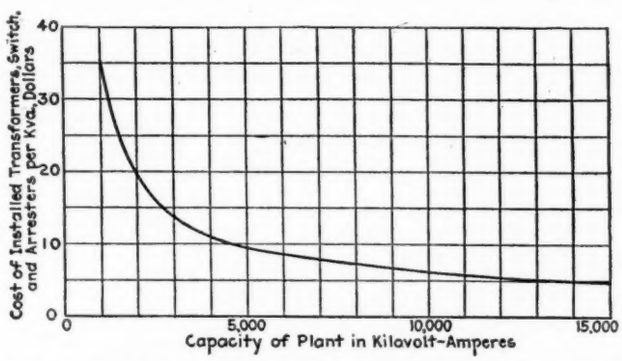


FIG. 5—COST OF CONNECTING SMALL STEAM GENERATING STATIONS INTO A 110,000-VOLT TRANSMISSION SYSTEM

nection with several coal mines and if possible, other coal fields.

To emphasize the great influence which condensing-water supply must necessarily exert in selecting the location of the steam station, a typical water-demand curve is presented in Fig. 2. Fig. 3 shows the river flow in cubic feet per second required to furnish condensing water for plants of various sizes when operating at 28½-in. vacuum, referred to sea level, and with cooling water at 60, 70 and 80 deg. F., respectively.

A study of Fig. 2 shows that for 28½-in. vacuum referred to sea level, with water at 70 deg. F., there is required a minimum of practically 385 tons of cooling water per ton of coal burned, on the basis of 9 lb. of evaporation. Most evidently, the cost of securing condensing water is a very vital factor. Not only is the quantity of water available important but its temperature also. Fortunately for the entire Southwestern Appalachian section, the water of the several streams is remarkably cool, usually being below

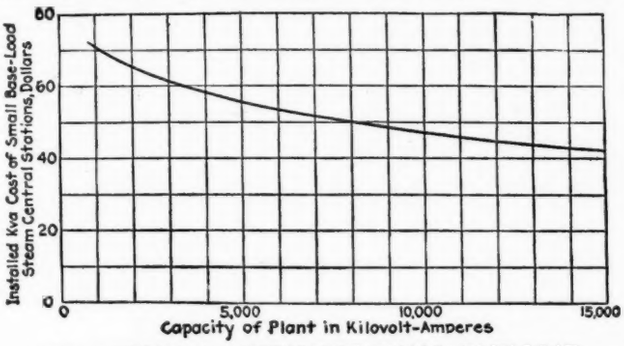


FIG. 6—COST OF INSTALLING SMALL BASE-LOAD TURBO-GENERATOR STATIONS

70 deg. F., even during the hottest weather. This is due to the source of the supply, practically all streams being fed by cold mountain springs. As we go out into the plains, however, river temperatures will average from ten to fifteen degrees higher than those of the mountain sections.

Where an insufficient volume of naturally cool water is available, the alternative of artificial cooling of a limited supply is sometimes to be considered. In this section spray cooling at midday during the height of summer cannot bring temperatures below 80 deg. F., and this temperature of condensing water precludes high-vacuum operation, since the boiling point of water at a 28½-in. vacuum is approximately 90 deg. For the operation of large steam plants spray cooling is, therefore, of doubtful expediency. For small plants, however, spray cooling is sometimes desirable; and when this is the case the mountain section again has an advantage over the lowlands for the reason that here lower relative humidities prevail, and hence the cooling effect of spraying is greater.

An engineer of the authors' acquaintance was recently called in by a coal operator to install a 300-kw. non-condensing turbine. The water supply available was limited, and both the purchaser and the representative of the turbine manufacturer with whom the order had been placed felt certain that a condensing unit could not be considered. The engineer, however, finally convinced them that the scarcity of water actually made the condensing outfit the more desirable. When he proved that the loss of water by evaporation and by drift from a spray pond would be much less than the difference between the steam consumption of the condensing and the non-condensing turbine, the order was changed and the condensing turbine installed. Less actual water was required to operate the condensing unit.

The question is often asked why it is necessary to install large central stations when a distribution of coal and of condensing water is more favorable to small plants. Aside from the much greater overhead cost of operating many small plants, we must consider the expense of connecting these small plants into a high-tension transmission system. The installation costs of the equipment for connecting in these stations (transformers, switches and lightning arresters) is so great per kilowatt of installed capacity as to be prohibitive. Fig. 5 shows the cost per kilovolt-ampere of transformers, switches and arresters required to connect into a 110,000 volt transmission system.

By comparison of the curves of Figs. 5 and 6, the latter showing the costs of small turbo-generator stations, in this district it is seen that the unit costs of the small-plant switching and transforming equipment reach prohibitive figures. The large base-load plant, strategically located with respect to fuel, water, and transmission systems, will be a vital factor in the superpower system of the future.

Boiler Troubles from the Operating Man's Standpoint*

By Carl J. Smith†

In the following paper on "Boiler Troubles," it is the intention to deal with troubles encountered in the operation and maintenance of steel-mill boilers as, no doubt, the troubles encountered in the operation of this class of boilers are more numerous than with the boilers in any other service, owing to the absence of any well-defined load curve, the absence of any considerable amount of condensate return and a large labor turnover in the operating forces.

The troubles of a steel-mill-boiler operating engineer may be separated into three classes: First, those due to faulty design and construction of the boiler plant; second, those due to the operators and their method of operation; third, all troubles that are not due to faulty design or faulty operation, but are incidental to the operation of boilers in this class of service.

In discussing the list of troubles, as viewed by the average boiler-house operating engineer, the most common of them all is "low steam." As originating in the boiler house, strictly speaking, "low steam" is not a trouble, but rather the effect of trouble. If all the other troubles of the boiler-house were eliminated, "low steam" would also be eliminated as far as the boiler-house is concerned.

In the ordinary steel mill, as the mill production depends on good steam pressure, the first rule is, keep the steam pressure up, and the second, go after economy. Under these conditions the boiler-house operating engineer, in order to escape the dire result of his boiler-house troubles, must be on his toes, pick his troubles young and overcome them before they multiply.

Leaky Settings a Common Trouble

One of the most common boiler troubles and one that causes serious loss in capacity and economy, is leaky boiler settings. To maintain settings approximately tight requires the constant attention of the operating force, and the results obtained repay many times over the cost of all the attention given.

Leaky baffles, causing short-circuiting of gases through the boilers, are a source of much loss in efficiency and economy, and boiler baffles should receive the careful attention of the operating force. Every time a boiler is taken off for cleaning and repairs, the baffles should be carefully inspected, pointed up and made tight.

Slow ignition is a trouble often met with on natural-draft traveling grates. This trouble is generally experienced with old-style settings, and its elimination is purely a question of locating the ignition arches so as to get a high localized temperature at the point of ignition. The use of properly designed flat arches is a great help in curing ignition troubles and lowering arch expense.

Furnace refractory troubles are generally caused by a poor grade of firebrick, poor bonding material, poor workmanship or poor design of brickwork. In the combustion chambers the best grades of firebrick are the cheapest. As good brick will not stand up with a poor bond, it will be found a paying investment to use special high-temperature cement, at least on the inner course of the furnace walls.

The average steel mill is afflicted with bad boiler-feed water, which is the cause of much boiler trouble from scale and mud. The installation of water softeners eliminates most of this trouble when operated correctly. However, the use of treated water necessitates frequent blowing down of the boilers to keep the concentration of soluble salts down below the point where trouble with foaming is encountered. Where raw water is used for boiler feed, the mud and scale must be cleaned out of the boilers at regular intervals. The wise boiler-house operating engineer will establish the best cleaning schedule for his boilers and will let nothing interfere with maintaining this schedule. The boiler washers and boiler-washing equipment are one of the most impor-

*Extract of paper presented at the Seventeenth Annual Convetion Association of Iron and Steel Electrical Engineers, Sept. 24, 1923, Buffalo, N. Y.

†Fuel Engineer, Inland Steel Co., Indiana Harbor, Ind.

tant branches of the average boiler house, and if they are neglected trouble quickly comes in the shape of burned tubes, low efficiency and capacity, and a long hard fight to get the boilers back in shape.

A careful analysis of all the troubles of steel-mill boiler plants will show that 90 per cent of the trobules are maintenance troubles rather than operating troubles. It is impossible to have an efficient, smoothly working boiler plant if the equipment is in poor condition. A good boiler-house foreman must be, in every sense of the word, an expert on maintenance work. He should carry the necessary spare parts and watch carefully every piece of equipment to see that it is properly handled and endeavor to spot trouble before it actually materializes. In this way he generally can sidestep trouble and avoid expensive delays and repairs. The difference between a good foreman and a bad one is that the good man spends the major portion of his time correcting the causes of trouble, whereas the bad foreman is busy correcting the effects of trouble.

The boiler-house foreman, besides being an expert on maintenance, must thoroughly understand the principles of economical operation and see that they are practiced by his operating force. He should have at least instruments enough to tell him what load his boilers are carrying and to ascertain thereby, in case of "low steam," whether the cause is in the boiler house or in some of the mills. He should also have a boiler-house logbook in which a record is kept of all repairs made and everything out of the ordinary that takes place in the boiler house. This record will be invaluable as a reference in following up his work.

Pressures Adopted for Standardizing High-Pressure Pipe Fittings

At a meeting of the Subcommittee No. 3, Pipe Flanges and Fittings for Pressures over 250 Lb. per Sq.In., on Oct. 26, at New York, the following steam pressures were adopted as standard for specifications of pipe flanges and fittings for high pressures and high temperatures: 400, 600, 900, 1,350, 2,000 and 3,200 lb. per sq.in. This subcommittee was sponsored by three societies, the Heating and Piping Contractors' National Association, Committee of Manufacturers on Standardization of Fittings and Valves, and the A.S.M.E. Specifications for flanges and fittings are being worked out for these pressures at 750 deg. F.

This range of pressures was adopted from considerations of present usage and manufacture, and also from the fact that they correspond to a system of preferred numbers. These represent approximately a geometric series whose ratio is 1.5. Flanges for 400 lb. and 600 lb. piping are to be specified at the earliest possible moment. Hydraulic standards for pipe flanges are to be utilized when possible as guides for these specifications. For the lower pressures it was decided that while specifications calling for alloy steel bolts may be developed, the fittings should nevertheless be drilled large enough so that in case of emergency, bolts of the usual grade of steel may be safely used.

A subcommittee has been appointed for determining safe stresses, and also a working committee consisting of 12 members for the purpose of attending to the detail work. These two committees met on Nov. 1, to proceed further with the actual work of standardizing pipe fittings.

The steel 250- and 400-lb. steam standards are to have the same bolt circle and number of bolts as the present American cast-iron standard for 250 lb., except that the 2- and 2½-in. sizes for the 400-lb. standard will have 8 bolts instead of 4. The other dimensions of these flanges are, however, to be modified to meet the conditions set for each.

The 600-lb. steam standard will use as the basis for its dimensions the bolt circle and the number of bolts of the present 800-lb. hydraulic standard developed by the A.S.M.E. committee and published in December, 1918.

The 900-lb. steam standard flange is to be based on the bolt circle and the number of bolts of the present 1,200-lb. hydraulic standard developed by the A.S.M.E. committee and published in December, 1918.

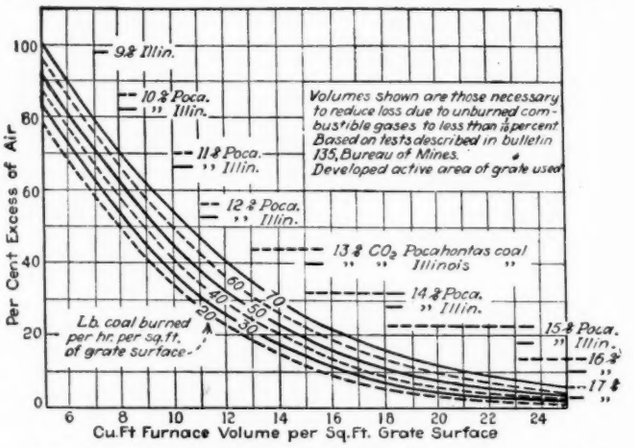
Flanges to withstand 1,350, 2,000, and 3,200 lb. steam pressures and the corresponding superheats are to be developed after the completion of the first four of the series. It will be noted that the seven maximum pressures selected form a geometrical series between the terms 250 and 3,200.

When the working committee receives the report of the subcommittee on the physical and chemical properties, it will begin its work on the dimensional standardization. It will then carry on its work intensively, since it is required to present its report to the members of the full subcommittee No. 3 in writing at least a week prior to the next meeting, which was set for the first week of December in New York at the time of the A.S.M.E. Annual Meeting.

Prof. Collins P. Bliss, of the Mechanical Engineering Department of New York University, who is chairman of the Sectional Committee, has decided to act also as chairman of this subcommittee. The other members of Subcommittee No. 3 are: J. C. Bannister, C. W. E. Clarke, Sabin Crocker, R. D. Hall, H. E. Haller, J. A. Hance, C. H. Haupt, H. C. Heaton, J. S. Hess, F. Hodgkinson, D. S. Jacobus, O. F. Junggren, M. B. MacNeille, V. T. Malcolm, W. S. Morrison, W. A. Pope, G. W. Saathoff, J. R. Tanner and H. L. R. Whitney. H. L. R. Whitney of the M. W. Kellogg Co., was elected secretary. This list includes official representatives of the American Society for Testing Materials, Hydraulic Society, Power Piping Society, National Electric Light Association, the A.S.M.E. Boiler Code Committee, and the Sponsor Bodies. A few of the members of this subcommittee were appointed "at large" because of special interest in and knowledge of this subject.

Approximation for Furnace Volume

While there probably can be no simple expression for the relation of the many factors involved in the determination of furnace volumes, says the Power Generation Committee of the American Electric Railway Association, one member



FURNACE VOLUMES FOR ILLINOIS AND POCAHONTAS COALS

company has used the curves here shown in an attempt to approximate a mathematical determination.

From these curves it is apparent that large furnace volumes are not necessary for high rates of combustion if increased excess air is permissible. Thus from the curves, if high CO_2 is demanded, permitting only of 20 per cent excess air, 15 cu.ft. of furnace volume per square foot of grate surface is necessary to burn 20 lb. of coal per square foot, the loss due to unburned combustible gases being limited to one-tenth of one per cent; but if 80 per cent excess air is permissible, 60 lb. of coal per square foot can be burned to the same one-tenth of one per cent limit in one-half the furnace volume.

It is not to be inferred that the curve illustrated shows the exact relation between furnace volume and rates of combustion, for there are many factors such as the direction and length of flame travel, which have important effects, but the curves do show that greater furnace volumes are required by high percentages of CO_2 than by high rates of combustion; that is, high rates where no limitation is placed upon the percentage of excess air.

News in the Field of Power

Tentative Program of the A. S. M. E. Annual Meeting Dec. 3-6

THE tentative program of the Annual meeting of the A.S.M.E., which will be held in New York City, Dec. 3-6, has been announced, although some of the papers and sessions are subject to change. These changes will be noted in *Power* as they are made.

MONDAY, DECEMBER 3

Morning—Opening of headquarters and registration bureau; conference local section delegates; council meeting.

Afternoon—Conference local section delegates.

Evening—Presidential Address John Lyle Harrington and reception. Awards of medals to Fred A. Halsey and John R. Freeman.

TUESDAY

Morning—Joint session with American Society of Refrigerating Engineers: "Heat Transfer for Fluids Flowing Inside Pipes," Wm. H. McAdams and T. H. Frost (contributed by A. S. R. E.); "The Economical Thickness of Insulation in Refrigerator Cars," A. J. Wood and Philip X. Rice (contributed by A.S.M.E.).

Textile session: "Organization and Construction of Woolen Mills," A. W. Benoit; "A Steam Loss Prevention Plan in a Textile Finishing Plant," Henry M. Burke.

General session: "A Graphical Study of Journal Lubrication," H. A. S. Howarth; "The Bending and Torsion of Multi-Throw Crankshafts on Many Supports," S. Timoshenko (by title).

Open meeting: Special Research Committee on Fluid Meters. Discussion of Part II of this report.

Afternoon—Business meeting.

Public hearing: (a) Power Test Code for Stationary Steam Generating Units; (b) Power Test Code for Locomotives.

Evening—Smoker and bridge for ladies.

WEDNESDAY

Morning—Fuel session: "Factors in the Spontaneous Combustion of Coal," O. P. Hood; "Economic Phases of Coal Storage," F. G. Tryon; "Coal Handling and Coal Storage," H. E. Birch and H. V. Coes (contributed by Materials Handling Division).

Railroad session: "Modern Subway Cars and Their Operation," S. Haar.

Ordnance session: "Advance in Physical Measurements in Ordnance Department Research," Col. W. E. Tschappat; "Industrial Preparedness Plans of the War Department," Capt. H. W. Churchill.

Afternoon—Forest products session: "Reforestation and Timber Conservation," by John W. Blodgett, President, National Lumber Manufacturers Association; Conference of committee on education and training; steam table research; ladies' tea.

Evening—Joint session with A.S.C.E. and A.I.E.E. on "Hydro-electric Power"; address by John R. Freeman, Past-president A.S.M.E.

THURSDAY

Morning—Power session: (a) Heat cycles, "Economy Characteristics of State Feed Water Heating by Extraction," E. H. Brown and M. K. Drewry; "High Pressure, Reheating and Regenerating for Steam Power Plants," C. F. Hirshfeld and F. O. Ellenwood; "Reheating in Central Stations," W. J. Wohlenberg; "Margins of Improvement in Central Station Steam Plant," E. L. Robinson; (b) "Boiler Plant Economics," N. E. Funk and F. C. Ralston.

Machine shop session: "Some Principles and Examples of Metal Development," D. P. Cook; "The Development of Modern Stamping Practice," W. W. Galbreath and John R. Winter; "Progress Report on the Present Status and Future Problems of the Art of Cutting Metals."

Aëronautic session: "Resistance of Various Aluminum Alloys to Salt Water Corrosion," D. Basch and M. F. Sayre; "Notes on Some Recent Observations Regarding the Corrosion, Cleansing and Protection of Aluminum Alloys," E. A. Gardner; "Commercial Possibilities of the Airplane," A. Black and D. Black.

Afternoon—Management session: Symposium, The Relation of Mechanical Engineering to Management in (a) The Metal-Working Industries, R. T. Kent; (b) The Wood-Working Industries, W. L. Churchill; (c) The Textile Industries, E. H. McKitterick.

Gas-power session: "Solid Injection Engines," H. F. Sheperd; "Economic Status of the Oil Engine," L. H. Morrison.

Water-measurement session: "Salt Velocity Method of Measuring Water," C. M. Allen and E. A. Taylor; "Flow of Water in Pipes," O. W. Boston (by title); "The Gibson Method and Apparatus for Measuring the Flow of Water in Closed Conduits as Applied in Testing the Efficiencies of Water Wheels in Hydro-Electric Power Plants," N. R. Gibson.

Evening—Dinner dance.

Coal Report Advises Improvement in Mining Methods

As the result of its engineering study on "Underground Management in Bituminous Mines," the United States Coal Commission believes that reductions can be made in the cost of production of coal through improvement in operating methods, without any reduction in wage rates by: Development of machinery to replace the irksome and solitary operation of hand loading; control of underground operations; improvement in the work of the individual; standardization of equipment.

Canada May Have Central Heating Plants

The Hon. Charles Stewart, Minister of the Interior and Mines in Canada, has appointed F. A. Combe, a Montreal steam and combustion engineer, to make an exhaustive report on the feasibility of establishing central heating plants throughout the Dominion. This move is in accordance with the policy of the Canadian Government to do everything possible toward a permanent solution of the fuel problem, leaving to local administrative bodies the task of dealing with emergency and concrete local problems.

Mr. Combe's investigation will be conducted under the supervision of the Dominion Fuel Board, and it is stipulated in the agreement with him that his report must be completed within six months. The report will deal not only with the history of central heating wherever it has been tried out and give descriptions of existing plants in the United States and Canada, but will also pay particular attention to the saving that can be effected by using low-grade fuels. Other phases of the subject to be dealt with include reasons for failure in unsuccessful central heating enterprises, possibility of combining electric generating and heating service and of using plants for making ice in summer, diagrams and plans of plants, rates, regulations, approximate costs, capital required and probable profit.

Mr. Combe is chairman of the Fuel Committee of the Engineering Institute of Canada and is a specialist in heating.

Central Stations Show Great Increase of Output

Power generated by central electric light and power stations, both commercial and municipal, and by electric railways, in 1922 as compared with 1917 and 1912, has been found, by the Department of Commerce, to have been 45,307,536,711 kw.-hr. in 1922 as compared with 32,678,806,061 kw.-hr. in 1917 and 17,621,808,893 kw.-hr. in 1912, an increase of 38.6 per cent from 1917 to 1922 and of 157.1 per cent for the ten-year period 1912 to 1922. These figures do not include the output of electric plants operated by mines, factories, hotels, etc., which generate for their own consumption, or those operated by the federal government and state institutions.

Susquehana River May Have Two New Developments

An important hydro-electric development near Harrisburg, Pa., is indicated by the filing with the Federal Power Commission of a declaration of intention by the Hydro-Electric Company. It is proposed to develop two sites on the Susquehanna River. One is at Clark's Ferry just above the mouth of the Juniata near Harrisburg, and the other is at Millersburg at the head of the pool it is proposed to create.

A long and expensive dam will be required but a head of 50 feet can be developed. In addition to the sale of power, the company expects to draw material profit from a roadway across the river, which is to be built on the crest of the dam. Toll is to be collected.

The declaration of intention also covers the construction of two dams and power houses on Tom's River in New Jersey. It seems probable that the Federal Power Commission will take jurisdiction over the Susquehanna development, but there is doubt as to whether or not the Tom's River project will affect navigable streams.

The Hydro-Electric Company just has been incorporated and is made up largely of engineers and other professional men living in Harrisburg.

Swope to Deliver First Aldred Lecture at M.I.T.

Gerald Swope, of the General Electric Co., will deliver, on the afternoon of Nov. 9, the first of the lectures to be given in the Aldred Course of Lectures which has recently been established at the Massachusetts Institute of Technology, Cambridge, Mass.

This course of lectures has been established by J. E. Aldred, because of his belief in the need of graduate engineers coming in contact with men who have made an outstanding success in their various lines. Through his varied experiences in the development of the hydro-electric power plants at Shawinigan Falls on the St. Maurice River, Quebec, and McCall Ferry on the Susquehanna River, as well as industrial operations in paper mills, carbide plants, and other industries, he has come to the conclusion that engineers make unfortunate mistakes through lack of practical application of their technical knowledge. He has therefore established these courses of lectures at Johns Hopkins University and at the Massachusetts Institute of Technology in the hope of bridging the gap between the young graduate and his professional work.

St. Anthony Falls Sold to Northern States Power Co.

The Northern States Power Co. has purchased from the Pillsbury Flour Mills Co. the properties and power rights at St. Anthony Falls on the Mississippi River. St. Anthony Falls has a drop of 65 ft. and capacity of 60,000 hp. Power now being developed at the Falls furnishes energy for the operation of the Pillsbury flour mills, which have a connected load of 32,000 hp., and the Minneapolis Street Railway System, with a connected load of 22,000 hp. The remainder of the power generated has been sold wholesale to the Northern States Power Co. This transaction brings back to local ownership the water power that has been responsible for the development of Minneapolis. Heretofore the Pillsbury-Washburn Flour Mills Co., Ltd., a British concern, owned all the property of the Pillsbury company in Minneapolis, and the American Pillsbury company leased it, but now they have acquired complete ownership of the British company's stock.

Shipping, Engineering and Machinery Exhibition Shows British Activity*

British Manufacturers Believe in Exhibiting Their Products

"THOUGH trade is stagnant in Great Britain, enterprise is very much alive." The truth of this observation was demonstrated conclusively by the exhibits at the Shipping, Engineering and Machinery Exhibition held last month in London.

The exhibition indicated that the British manufacturers of machinery are taking advantage of the present lull in their production departments to concentrate on research and on refinements for their products.

In addition to complete displays of boilers, stokers, machine tools, electrical apparatus, steam specialties, valves and a great profusion of equipment in some 300 separate exhibits, there was an unusual array of marine and stationary internal-combustion engines, motor boats and all manner of accessories presented by the Society of Motor Manufacturers and Traders, Ltd. A number of complete motor-propelled small boats and yachts were brought into the hall—a task which would have been impossible except in such a place as Olympia at West Kensington, a building especially designed for this type of exhibition. There is frequent use for such a structure, as the British manufacturers are strong believers in backing up their advertising campaigns with exhibits of their products, so that prospective customers may visualize advertising claims.

If that exhibition was typical of the ingenuity, the patience, the genius and the hopes of Great Britain's shipping, shipbuilding, engineering and motor-boat industries, it bespeaks much for the continued progress of those arts.

The exhibition was managed by F. W. Bridges. Sir Charles A. Parsons, head of the Parsons Electrical and Engineering Works at Newcastle-on-Tyne, head of the Parsons Steam Turbine Co., Ltd., and of many other enterprises, was honorary president of the exhibition.

Some 325 separate exhibitors participated in the exhibition, but many of them presented several exhibits. Descriptions of some of the exhibits follow:

The Parsons Marine Steam Turbine Co., Ltd., presented a working model of a double-reduction geared turbine as fitted in merchant vessels. There was a model of the interior of an engine room, showing a single-screw arrangement of the machinery. A gear wheel and pinions taken from a naval vessel, after having been used for 160,000 miles, were shown.

The Sperry Gyroscope Co. had an impressive exhibit of its various products. Compasses were shown in operation, as were repeaters and control panel. Working in conjunction with the compass was the automatic course recorder, which produces a permanent graphic record of all the movements of a ship's head, thereby facilitating dead reckoning calculations. No model of the stabilizer was shown, but a series of photographs made clear the operation of that device.

The exhibit of the Steam Plant Accessories, Ltd., was in four sections. There were steam valves of extra-heavy design, with renewable disks and seats, of phosphor bronze and nickel alloy for superheated steam. Many types with screwed and bolted covers also with inside and with outside screws, were shown. A special feature was made of small pet cocks and drain cocks, for use on high-pressure steam. There was a new design of tank gage operated by screw-down valves and so arranged that the passages can be cleaned and new glasses inserted without interfering with the spindles.

William Boby & Sons made quite a feature of a recently introduced type of water softener. The machine produces soft water without the use of chemicals other than salt. It is claimed that the plant operates perfectly, even when the water supply may be from more than one source, with different degrees of hardness. In addition, the company displayed lime and soda plants. One form allows for the varying of the proportions of reagents, while the machine remains at work.

Babcock & Wilcox, Ltd., featured its mechanical chain-grate stoker of the compartment type in operation. In addition, it had numerous models of land and marine types of water-tube boilers and samples of its oil-fuel burners. Every emphasis was placed on the fact that the company has supplied 168,000,000 sq.ft. of boilers for land work and 70,000,000 sq.ft. for marine work.

It would take a volume to describe all of the exhibits. While some were much more pretentious than were others, all were cleverly presented and in charge of men who knew the equipment thoroughly.

*By Paul Wooton, Washington correspondent of *Power*.

Chicago Engineers Observe Management Week

Management Week, Oct. 22-27, was observed by Chicago engineers. A program was carried out under the auspices of the local sections of the American Society of Mechanical Engineers, the National Association of Cost Accountants, the Society of Industrial Engineers, the Taylor Society and the Western Society of Engineers. The plan in Chicago, for this annual observance, was to concentrate the attention of executives and engineers upon the practical application of the science of management as a factor in promoting the stabilization and prosperity of American industry and to bring together the various participating societies to further the effective co-ordination of the various functions of management.

The opening session was held in the auditorium of the Western Society of Engineers. Bion J. Arnold presided. "The Story of an Automobile," presented in an excellent six-reel film,

showing the various steps in the making, assembly and testing of the Studebaker Light Six served as an interesting introduction. W. C. Hoover of the B. F. Goodrich Co., followed with an address on "Multiplying Man Power by Mechanical Means." His remarks centered upon material handling in the big tire-making plants of the company by means of conveyors and trucks, the mixing of the batch, the arrangement of the calendars and some of the modern improvements in equipment and routing that had saved space and labor.

On Thursday a dinner meeting at the City Club was devoted to "Non-Mechanical Means of Increasing Man Power," with W. L. Abbott, chief operating engineer of the Commonwealth Edison Co., acting as chairman. J. D. Cunningham, speaking for the American Society of Mechanical Engineers, urged the engineer to analyze himself, to improve in the salesmanship of his own abilities and to take the active part in management that his qualifications warranted. In the past he had been used as a handbook, being called out to give the information desired and then placed back on the shelf to allow another man to carry out the work and receive the credit. Possessing three main characteristics to a greater degree than other men—namely, the power to observe, the ability to be logical and an analytical turn of mind—he was well qualified to follow the work through and to enter into many parts of management where he had never been used before. To do this he must improve as a business man and become a better salesman of his own abilities.

Hugo Diemer, representing the Taylor Society, outlined the different phases of industrial relations and personnel work and by numerous data and statistics showed how they had become vital factors in increasing man power.

W. B. Castenholz offered a few concrete examples of how the accountant helped in management. To present the usual type of inventory did not begin to express his duties. He must get back of the figures, analyze the process and sequence of mechanical operations, proportion the investment in machines so that all departments balance and no time is lost in any one part of the plant, insure a properly proportioned inventory, based on the sales requirements, and in fact tell the management whether the maximum results are being obtained out of a minimum investment.

H. N. Stronck pictured the growing field of the industrial engineer. The subdivision of control and responsibility to get mass production and the formation of vertical trusts in which the various units were widely separated, from a geographical standpoint, and engaged in different lines, required a co-ordinator of all branches of the business whose duties would be to prevent duplication and overlapping of work, time losses in man power and equipment, partial waste of fixed assets, non-availability of resources due to unbalanced inventory, etc. It was not a difficult task to draw up a good plan of operation. The more difficult part of the problem was to line up the organization to conform with the plan, and this was particularly true in the older and more established companies. The tendency of the day was toward standardization of product and with it the process plan of manufacture, demonstrated in the large automobile plants, was coming more into vogue. These tendencies required intensive development of sub-controls, their close co-ordination under a master control and the development of an organization to see that the sub-controls keep in line with the master control.

Fineness of Pulverized Coal

In conjunction with the committee on coal and coke of the American Society for Testing Materials, methods for making size tests of powdered coal, both by hand and machine sieving, have been formulated by W. A. Selvig, assistant analytical chemist, attached to the Pittsburgh experiment station of the Bureau of Mines, Department of the Interior, and sent to various co-operating laboratories for trial and criticism. This work will be continued with a view to formulating a satisfactory standard for making fineness tests of powdered coal.

Community Coal Storage Report Published by Fuel Distributor

The Federal Fuel Distributor has just published the, "Community Coal Storage" report, which is based upon the studies made in Minneapolis, St. Paul, Chicago, Indianapolis, Worcester, Lowell, Buffalo, Cleveland and Detroit, to determine the feasibility and economic possibilities of the operation of large central community coal storage yards. The report covers the advantages and disadvantages of a community coal yard and the possibilities of spontaneous combustion.

New Canadian Boiler Company Organized

The Babcock & Wilcox, Ltd., of London, Eng., the Goldie & McCulloch Co., Ltd., of Galt, Ontario, Canada, and the Babcock & Wilcox Co., of New York, announce that they have organized a new Canadian company under the name of Babcock Wilcox & Goldie McCulloch, Ltd., for the purpose of manufacturing and dealing in boilers, accessories, pumps, turbines, condensers, etc., in Canada. The new company will have its headquarters in the City of Galt, Ont., and branch offices in Vancouver, Winnipeg, Toronto and Montreal. R. O. McCulloch will be president, A. R. Goldie vice-president and A. G. Pratt of New York will be chairman of the Board. The Goldie McCulloch Co., Ltd., will continue to manufacture and deal in vaults, safes and safety deposit boxes at Galt, Ont.

Moore School of Electrical Engineering Started at U. of P.

The University of Pennsylvania has recently been enabled to establish a new school of electrical engineering through a bequest left for the purpose, by Alfred Fitler Moore, a former manufacturer of wire in Philadelphia, who died in 1912. Harold Pender has been appointed Dean of the new school, which on Oct. 19, had an enrollment of 140.

Milwaukee Considering New Smoke Ordinance

Milwaukee has now pending in the Common Council, an amendment to the Smoke Ordinance, which has been referred to the Inspector of Buildings with the request that he appoint a committee who will prepare a smoke ordinance satisfactory to everyone concerned. The proposed committee is to have a representative from the Smoke Inspection Department, Board of Examiners Stationary Engineers, Milwaukee Engineers' Society, National Association of Stationary Engineers, Practical Organized Operating Engineers, Larger Manufacturers of the City.

New Publications

Power; Its Application from the 17th Dynasty to the 20th Century. An address by F. L. Morse, delivered at the 26th annual convention of the American Mining Congress, Milwankee, Wis., Sept. 27, 1923. Published by the Morse Chain Co., Ithaca, N. Y. Paper; 46 pages; illustrated. Free.

A quaintly delightful booklet is here presented, on the history of power and its application from 2,800 B. C., when elbow greese and the wind were the only known source of it, down to and including the chain system of its transmission today. Tomb paintings, woodcuts from old manuscripts, drawings from Leonardo's notebook and illustrations from all sources enrich this interesting presentation of power and power-transmission history.

Friction. By T. E. Stanton. Published by Longmans, Green & Co., New York and London. Cloth; 5¼x8¼ in.; 80 pages; 70 illustrations. Price, $4.20.

The author, who is superintendent of the Engineering Department, British National Physical Laboratory, has undertaken, quite successfully, to assemble the several generally accepted theories on friction. His attempt to interpret the results of experiments on lubrication is of interest, and since the volume is obviously written for the physicist, the extensive use of involved mathematics does not, for this class of readers, detract from its usefulness. For the engineer who is not familiar with calculus, the work cannot be of maximum service, although there are many paragraphs containing information that could be of benefit to the practical man.

Der Torsionsindikator—III Teil. By Dr. (Ing.) Paul Nettmann. Published by M. Krayn, Berlin W.10, Genthiner Strasse, 39. Paper; 7x10 in.; 142 pages. 65 illustrations. Price, $1.15.

This volume deals theoretically with the subject of torsions and torsion meters. It contains many illustrations and charts and a good bibliography at the end of the volume.

Handbook No. 26 on Mayari Pig Iron—Published by the Bethlehem Steel Co., Inc., Bethlehem, Pa. 103 pages. Cloth 5x7½ in. Price $1.

This handbook describes the nature and uses of natural nickel-chromium alloy for making high-grade castings and contains some interesting and useful data compiled especially for it by Dr. Richard Moldenke as well as tables of tests, illustrations and index.

Japan After the Earthquake—Trade Information Bulletin No. 147. By F. R. Eldridge, Jr. Published by the Bureau of Foreign and Domestic Commerce. Government Printing Office, Washington, D. C. Free.

The States of Brazil—Trade Information Bulletin No. 148. Prepared by George R. Coxe, of the Bureau of Foreign and Domestic Commerce, and published by them. Government Printing Office, Washington, D. C. Free.

Instructions for the Care and Operation of Power Transformers—The successful operation of transformers is dependent upon proper installation and operation as well as upon proper design and manufacture. While a transformer requires less care than almost any other type of electrical apparatus, neglect of certain fundamental requirements may lead to serious trouble, if not to loss of the transformers. For this reason, a wide distribution of information in regard to the proper care of transformers is important. With this thought in mind, The Electric Power Club, Cleveland, Ohio, has issued an 8 page instruction booklet on this class of equipment.

Society Affairs

The **Providence Engineering Society** will hear H. B. Oatley, vice-president of the Superheater Co., New York City, speak on "High Pressure Steam" on Nov. 6.

The Metropolitan Section of the A.S.M.E. will hear W. R. Webster, of the Bridgeport Brass Co., speak on "Condenser Tubes" at its Nov. 8 meeting.

Liberty Association, No. 15 of the N.A.S.E., 514 Vine St., Cincinnati, Ohio, will have a meeting on the evening of Nov. 10 at which Nicholas Rouse will speak on "Heat Balance."

The Franklin Institute of Pennsylvania will hear F. W. Peck, Jr., of the General Electric Co., Pittsfield, Mass., lecture on "High Voltage Phenomena" on Nov. 15 in the lecture room of the Institute at Philadelphia.

The Engineers' Club of Philadelphia will tender a dinner to Charles M. Schwab, who was recently elected an honorary member of the club, at 7 p.m. on Nov. 20, at the Bellevue-Stratford Hotel, Philadelphia, Pa.

Coming Conventions

American Association for the Advancement of Science. Burton E. Livingston, Smithsonion Institution Bldg., Washington, D. C. Seventy-fifth anniversary meeting at University of Cincinnati, Cincinnati, Ohio, Dec. 27-Jan. 2.

American Engineering Council of the F.A.E.S. L. W. Wallace, 24 Jackson Place, Washington, D. C. Meeting at Washington, D C., Jan. 10-11.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Midwinter convention at Philadelphia, Feb. 4-8.

American Society of Heating & Ventilating Engineers. C. W. Obert, 25 West 39th St., New York City. Annual meeting at New York City, Jan. 22-25.

American Society of Mechanical Engineers, Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Dec. 3-6.

American Society of Refrigerating Engineers, William H. Ross, 35 Warren St., New York City. Nineteenth Annual Convention at Hotel Astor, New York City, Dec. 3-5.

American Society of Safety Engineers. Genevieve S. Wood, 29 West 39th St., New York City. Annual meeting at New York City, Jan. 18.

Association of Railway Electrical Engineers. Jos. A. Andreucetti, Room 413, Chicago & Northwestern R.R. Station, Chicago, Ill. Thirteenth Annual Convention at Hotel La Salle, Chicago, Ill., Nov. 6-9.

Electric Power Club. S. N. Clarkson, 900 B. F. Keith Bldg., Cleveland. Fall meeting at French Lick Springs Hotel, French Lick, Ind. Nov. 19-22.

Engineering Institute of Canada. Fraser S. Keith, 176 Mansfield St., Montreal, Canada. Annual General Meeting at Montreal, Quebec, Jan. 22—Ottawa, Ontario, Jan. 23-24.

National Association of Practical Refrigerating Engineers; Ed. H. Fox, 5707 W. Lake St., Chicago. Fourteenth Annual Convention at Memphis, Dec. 12-16.

National Electric Light Association—Southeastern Division. Charles A. Collier, Georgia Railway & Power Co., Atlanta, Ga. Meeting at Hillsboro Hotel, Tampa, Fla., Nov. 19-22.

National Exposition of Power and Mechanical Engineering; Charles F. Roth, Room 1102, Grand Central Palace, New York City. Power Show, Dec. 3-8.

National Marine Engineers' Beneficial Association. Geo. A. Grubb, 313 Machinists' Bldg., Washington, D. C. Annual Convention at Franklin Square Hotel, Washington, D. C. Jan. 21-26.

Society of Automotive Engineers, Coker F. Clarkson, 29 West 39th St., New York City. Annual meeting at General Motors Bldg., Detroit, Mich., Jan. 22-25.

Society of Naval Architects and Marine Engineers, Daniel H. Cox, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 8-9.

The Lehigh Section of the A.I.E.E. will hold its second meeting on Nov. 16-17 at Pottsville. Mr. Wells, chief engineer of the J. G. White Corp., will speak on "Pine Grove Power Plant"; Mr. Lesser, of the Madeira Hill Coal Co., on "Mine Hoisting."

Personal Mention

Carleton J. Lauer, consulting engineer, 16 Edgewood Crescent, Rosedale, Toronto, Ont., Canada, formerly chief engineer of the Detroit Steam Motor Corp., Detroit, Mich., has recently become connected with the Brooks Steam Motors, Ltd., as chief engineer.

C. S. Taylor, formerly power engineer, was appointed deputy engineer-in-chief and manager of the Shanghai Municipal Electricity Department, 17 Foochow Road, Shanghai, China, last January, succeeding A. H. Blagden, who resigned after twenty-one years of service.

Charles P. Tolman has recently resigned as chief engineer and chairman of the Manufacturing Committee of the National Lead Co., although still continuing to render service to the National Lead Co. in the capacity of consulting engineer, and has established an office for general consulting engineering practice at 111 Broadway, New York City.

Obituary

William J. Lloyd, general superintendent West Lynn works of the General Electric Co., died suddenly at Swampscott, Mass., Oct. 28. He was born at Philadelphia in 1866 and in 1883 was graduated from Lehigh University with the degree of mechanical engineer. For a time he was employed by the Westinghouse Electric & Manufacturing Co., and about twenty-five years ago joined the General Electric organization. For five years he was at Rugby, England, with the British Thomson-Houston Co., and later was at the Pittsfield, Mass., works of the American organization. About fifteen years ago he was sent to Australia to establish the General Electric Co.'s plant in that continent, being transferred to Lynn about three years later.

Business Notes

The Elliott Company, Jeannette, Pa., has recently started a house organ entitled *Powerfax*, devoted to information for engineers and operators of steam-power plants, which it intends to publish bi-monthly and which it will send to power-plant men who are interested.

The Newport News Shipbuilding and Dry Dock Co. has taken over the future hydraulic-turbine business of the Wellman-Seaver-Morgan Co., of Cleveland and Akron, Ohio. The Wellman-Seaver-Morgan Co. will complete its present contracts and carry out the guaranties and obligations thereof without reference to the Newport News Shipbuilding and Dry Dock Co. The sales offices of the Wellman-Seaver-Morgan Co. in New York City, San Francisco, and Birmingham, Ala., will continue to function as heretofore and will represent the Newport News Shipbuilding and Dry Dock Co. in hydraulic-turbine work.

The Quaker City Rubber Co., manufacturer of rubber belting, packings, valves, etc., announces that all departments of its organization will be moved to the factory at Wissinoming, Pa., a suburb of Philadelphia.

The **Shepard Electric Crane & Hoist Co.**, 30 Church St., New York City, announces some changes in its business offices: H W. Gledhill, Eastern sales manager, will open a new office in Philadelphia at 121 N. Broad St.; A. J. Barnes will manage the New York City office and will also be in charge of export sales and advertising; H. A. Baugh will be in charge of the Pittsburgh office in the Union Arcade Bldg.; D. B. Patterson will have charge of the Baltimore office in the Lexington Bldg.; W. B. Briggs will be in charge of the Chicago office in the Peoples Gas Bldg.; W. H. Ringe will supervise the San Francisco office at 16 California St.; F. R. Quigley will have charge of the Birmingham, Ala., office at 507 Woodward Bldg.

Trade Catalogs

Diesel Engines—Fulton Iron Works Co., St. Louis, Mo. Catalog No. 805, "Fulton Diesel Engines" contains 32 pages of descriptions and illustrations showing actual installations.

Oil Burners—French Rotary Oil Burner Co., Sebastopol, Calif. Catalog No. 10 shows in a condensed manner with ample illustrations these oil burners for domestic and commercial purposes. The burners are controlled automatically for hot air, hot water and steam heating systems.

Boiler Trimmings—Wright Austin Co., Detroit, Mich. Bulletin No. 500 describes safety alarm water column for boilers and also trimmings for boilers.

Separators and Exhaust Heads—Wright Austin Co., Detroit, Mich. Booklet No. 300 describes with illustrations, tables of dimensions, etc., these separators.

Tachometer—Bailey Meter Co., East 46th at Euclid, Cleveland, Ohio. Bulletin No. 200 contains descriptions and drawings of this tachometer which is used for recording speed from $\frac{3}{8}$ r.p.m. up to 6,000 r.p.m.

Meters—Bailey Meter Co., East 46th at Euclid, Cleveland, Ohio. Bulletin No. 161 contains descriptive matter and illustrations of multi-pointer gages for indicating pressures, drafts, temperatures, flow, speed, etc.

Gasoline Storage and Distributing Equipment—S. F. Bowser & Co., Inc., Fort Wayne, Ind. Catalog describing and fully illustrating pumps, tanks and devices for handling gasoline, oils and other liquids. Tables of capacities, and the specifications and purposes of the equipment are clearly stated, making this catalog valuable for reference.

Welding and Cutting Equipment — Torchweld Equipment Co., 224 North Carpenter St., Chicago, Ill. Catalog No. 23 covers the complete line of oxy-acetylene weld and cutting apparatus, lead welding, soldering, brazing and decarbonizing units, gas-pressure regulators, automatic machines, generators and supplies. Many illustrations and a price list add to the usefulness of this catalog.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Oct. 22, 1923	Oct. 29, 1923
Pool 1,	New York	$2.85@3.25	2.85@3.25
Smokeless,	Columbus	2.85@3.25	2.00@2.65
Clearfield,	Boston	1.50@2.40	1.50@2.50
Somerset,	Boston	1.75@2.75	1.75@2.75
Kanawha,	Columbus	1.75@2.00	1.75@2.00
Hocking,	Columbus	1.75@2.00	1.75@2.00
Pittsburgh No. 8	Cleveland	1.80@1.90	1.80@1.90
Franklin, Ill.	Chicago	2.25@3.00	2.25@3.00
Central, Ill.	Chicago	2.00@2.25	2.00@2.25
Ind. 4th Vein,	Chicago	2.50@2.75	2.50@2.75
West Ky.,	Louisville	1.50@1.85	1.50@1.85
S. E. Ky.,	Louisville	1.50@2.00	1.50@2.00
Big Seam,	Birmingham	1.75@2.15	1.75@2.15

FUEL OIL

New York—Oct. 31, light oil, tank car lots, 28@34 deg. Baumé, 3$\frac{3}{4}$c. per gal., 36@40 deg. 4c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Oct. 22, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.60 per bbl.; 26@28 deg., $1.70; 28@30 deg., $1.80; 32@36 deg., gas oil, $1.90; 36@40 deg., distillate, $2.15@2.25 per bbl.

Pittsburgh—Oct. 26, f.o.b. local refinery, 30@34 deg., fuel oil, 5$\frac{1}{2}$c. per gal.; 36@40 deg., fuel oil, 5$\frac{7}{8}$c.; 34 deg., neutral 8c.

Dallas—Oct. 27, f.o.b. local refinery, 26@30 deg., $1.35 per bbl.

Cincinnati—Oct. 23, tank-car lots f.o.b. local refinery, 26@30 deg. Baumé, 5c. per gal.; 30@32 deg., 5$\frac{1}{4}$c.; 38@42 deg., distillate, 6$\frac{1}{4}$c.

Philadelphia—Oct. 26, 26@28 deg., $1.68@1.722 per bbl.; 16@20 deg., $1.50@1.55; 14@16 deg., $1.45@1.515.

New Plant Construction

PROPOSED WORK

Ark., Pine Bluff—A. H. Miller, Genl. Delivery, is in the market for three 150 hp. return tubular boilers or two 300 hp. water tube boilers; three oil storage tanks, 5,000 to 10,000 gal. capacity (used).

Calif., Oroville—The Directors of Thermalito Irrigation Dist. will receive bids until Nov. 9 for the construction of Lake Wilenor storage work, known as Concow dam. Bids will be received on 3 alternative sizes, as follows: schedule 1 covers dam constructed to a crest elevation of 1,947 ft. or about 75 ft. high; schedule 2, dam constructed to crest elevation of 1,947 ft. or about 75 ft. high of a different thickness than schedule 1; schedule 3, dam constructed to crest elevation of 1,967 ft. or about 105 ft. high. The size of dam will be determined by proposed joining of Table Mountain Irrigation Dist. with Thermalite Dist. in costs of benefits of reservoir. The dam is of constant angle arch type. S. J. Norris, Oroville, Ch. Engr. L. Jorgensen, Hobart Bldg., San Francisco, Consult. Engr.

Calif., San Francisco—The Constructing Quartermaster, Fort Mason, will receive bids until Nov. 16 for oil burning equipment and oil storage tank for Fort McDowell.

Calif., San Francisco—The Office of the United States Engineer, 85 2nd St., received lowest bid for furnishing one 20 in. booster pump and spare parts from the Main Iron Wks., 16th and Daggett Sts., San Francisco, $9,685. Noted Sept. 25.

Conn., Berlin—The Donnelly Brick Co. is having plans prepared for the construction of a 60 x 160 ft. power house. Estimated cost $40,000. M. J. Unkelbach, Main St., New Britain, Archt.

Conn., Middletown—The City Water Dept. is having plans prepared for the construction of a pumping station on Highland Ave. Estimated cost $40,000. J. W. Mylchrest, Engr.

Ill., Chicago—The Glover Laundry Co., 222 South Morgan St., is in the market for a Corliss engine, heavy duty frame, 20 x 42 in., 100 r.p.m., 150 lb. pressure or a 300 kw. a.c. direct connected unit.

Ill., Chicago—E. G. McClellan, Archt., 7441 Cottage Grove Ave., is receiving bids for the construction of a 1 and 2 story, 100 x 125 ft. ice plant on Hoyne Ave. and Walton Pl. for the West Side Ice Co., 839 North Hoyne Ave. Estimated cost $50,000.

Ill., Freeport—J. Knobel & Son, 4 Exchange St. (produce), are in the market for refrigeration machinery, several ton capacity, motor or belt drive.

Ill., Princeton—The Consumers Artificial Ice Co. is in the market for one 50 or 60 hp. oil engine, vertical type.

Kan., Kansas City — The city plans to purchase twenty pumps to force surplus water from sewers to river. Estimated cost $185,000. S. H. McNeil, Engr.

Kan., Kansas City—The city voted bonds for improvements to light plant, to include installation of four 600 hp. boilers for light department, $150,000; 12,000 kva. turbine generator to increase capacity of plant from 12,000 to 37,500 kva., $375,000; transmission lines $200,000. Noted Sept. 18.

Ky., Ashland—The Kentucky Face Brick Corp., 2nd Natl. Bank Bldg., is in the market for a 300 hp. engine, boilers and undershot water turbine.

Ky., Madisonville—The Madisonville Ice & Laundry Co. plans to rebuild its ice plant, which was recently destroyed by fire. Estimated cost $60,000.

Mass., Boston — The city, Public Bldg. Dept., is having plans prepared and will soon receive bids for the construction of a 4 story, 150 x 300 ft. high school on Warren, Townsend and Harrishof Sts. Estimated cost $3,000,000. H. H. Atwood, Ashmont (Boston P. O.), Archt. Equipment detail not reported.

Mich., Kalamazoo—The Valley Paper Co., 401 Press Bldg., is having plans prepared for the construction of a paper mill and water filtration plant. Estimated cost $500,000. Billingham & Cobb, 404 Press Bldg., Archts. The owner will purchase complete heating and ventilating apparatus, one high speed motor driven paper machine, beaters, pumps, etc.

N. J., Clifton (Passaic P. O.) — The Passaic Valley Sewerage Comrs., J. H. Quigg, Clk., 900 Chamber of Commerce Bldg., 24 Branford Pl., Newark, will receive bids until Nov. 13 for furnishing and installing electric motor driven pumping plant, consisting of three individual centrifugal pumping units, about 5,500,000 g.p.d. capacity; one gasoline engine driven electric generating set of adequate capacity for and arranged to drive either of three centrifugal pumping units, with switchboard, automatic control, electric wiring, piping, steam heating plant, etc., for the Yantacaw pumping station, here.

N. J., Hightstown—Peddie Institute, c/o R. W. Swetland, plans to build a steam plant. Estimated cost $50,000. Engineer or architect not selected.

New York—The state, Capitol, Albany, is having plans prepared for the construction of buildings and additions to each of the

State Hospitals as follows: Binghamton, $750,000; Brooklyn and Creedmoor, $6,000,000; Rochester, $1,200,000; Buffalo, $1,000,000; Central Islip, $3,000,000; Gowanda, $3,000,000; Kings Park, $3,000,000; Manhattan, $3,000,000; Hudson River, $3,500,000; Middletown, $1,000,000; St. Lawrence, $1,400,000; Utica, $750,000; Marcy, $3,000,000; Willard, $600,000; Dannemora, $100,000; Mattawan, $2,250,000. S. W. Jones, State Archt.

N. Y., Brooklyn—The Brooklyn Edison Co., Pearl St., is having plans prepared for the construction of a 1 story, 58 x 112 ft. substation on West 12th St. near Neptune Ave. Estimated cost $60,000. Private plans.

N. Y., Central Islip—The State Hospital Comn., Capitol, Albany, will receive bids until Nov. 14 for the construction of three cottages, including heating system, etc., at the State Hospital, here. S. W. Jones, Capitol, Albany, Archt.

N. Y., Elba—The Elba Cold Storage Co., Inc., C. Eismann, c/o Buffalo Vegetable Marketing Co., 29 East Market St., Buffalo, Genl. Mgr., is in the market for refrigeration equipment, etc., for new cold storage plant, here.

N. Y., Flint (Stanley P. O.)—The Flint Cold Storage, Inc., T. D. Whitney, Pres., plans to build a cold storage plant, 50,000 bbl. capacity. Estimated cost $200,000. Engineer or architect not selected. The owner is in the market for complete ammonia type cooling system, equipment, etc.

N. Y., Gouverneur—The city voted for the construction of a lighting plant. Estimated cost $100,000. Engineer not announced.

N. Y., Herkimer — The city, A. Clark, Supt., plans the installation of additional equipment for electric light plant, including turbine, boiler, etc. Estimated cost $75,000.

N. Y., McKeeseville — Prescott & Sons, manufacturer of furniture, F. Prescott, Purch. Agt., are in the market for a motor generator set and about 150 hp. in motors, sizes from 2 to 15 hp., 3 phase, 60 cycle, 220 volt, complete with meters, boards, switches, compensators, etc.

N. Y., New York—N. J. Hayes, Comr. of Water Supply, Gas & Electricity, Room 2351, Municipal Bldg., will receive bids until Nov. 9 for furnishing and installing electric valve operating equipment.

N. C., Durham—The city, R. W. Rigsbee, Mgr., is having surveys made for extension of water system, including new mains, large dam on Flat River to create a 4,000,000,000 gal. reservoir, also a hydro-electric plant.

N. C., Elon College—Elon College, W. A. Harper, Pres., plans to expend several hundred thousand dollars for the construction of buildings, water, sewer and heating plant.

N. C., Wilkesboro — The city is in the market for machinery for light and power plant, to replace that which was recently destroyed by fire.

Ohio, Cleveland—The city will be in the market after passage of bond issues for one 15,000 kw. turbo generator with condensor, steam and water circulation equipment and switching facilities, estimated cost $460,000; additional boilers and stokers, $200,000; coal storage equipment, $40,000; substation equipment and 11,000 volt transmission cables, $400,000; overhead street lights, equipment and distribution service, $400,000. Noted Oct. 9.

Ohio, West Toledo (Toledo P. O.)—The Citizen's Necessity Co., J. Murphy, Pres., plans to build a 140 x 200 ft. ice and storage plant on Berden Ave. Estimated cost $250,000. Engineer or architect not announced. Complete ice manufacturing equipment and cold storage system will be purchased.

Okla., Sulphur—The Consumers Light & Power Co. plans to equip ice plant with ice making machinery and raw water plant. Estimated cost $35,000.

Pa., Phila.—The Interstate Warehouse & Storage Co., 919 North Front St., will soon award the contract for the construction of a 7 story, 52 x 106 ft. warehouse, including refrigeration system, at 3935-37 Germantown Ave. Estimated cost $225,000. Moores & Dunford, Inc., 342 Madison Ave., New York, Archts.

Pa., Phila.—The Phila. Electric Co., 10th and Chestnut Sts., has purchased several tracts on the Delaware River front, totalling 55 acres, as site for new power plant, plans are under way for a steam generating station, about 200,000 kw. capacity, to be increased eventually to 600,000 kw.

Tenn., Arlington—The town will hold an election Nov. 10 to vote $5,000 bonds for a waterworks and electric light plant.

Tenn., Chattanooga — The Tennessee Power Co., Hamilton Natl. Bank Bldg., authorized a $1,000,000 bond issue for construction, extensions and improvements.

Tenn., Nashville—The Office of the United States Engineer, Customs House, is in the market for a complete Diesel marine engine.

Tex., Navasota — The Western Public Service Co., P. Freeman, Supt. plans improvements and additions to plant, including a 35 ton motor driven ice machine, 25 ton additional tank capacity, building, installation of 350 hp. Heinie boilers, 300 kw., d.c. electrical unit and a 25 x 30 ft. boiler room. Estimated cost $40,000.

Va., Richmond — The Hackley Morrison Co., 1708 Lewis St., is in the market for one 75 hp. squirrel cage motor, 3 phase, 60 cycle, 220 volt, 1,800 r.p.m.

Wash., Lake Cushman—The City of Tacoma, Commissioner of Lights & Water, is receiving bids and will open same about Dec. 1 for the construction of an arch concrete dam, 275 ft. high, 350 ft. long at the 230 ft. elevation and 800 ft. long on the crest, here. Estimated cost $1,250,000. J. L. Stannard, City Hall Annex, Tacoma, Engr. Bids will be received about the first of the year for furnishing two 17,500 kw. units, vertical type waterwheels, to be operated under 260 ft. head; also transformers, etc., for power house. Plans for the construction of the power house will be ready early next spring. Noted May 1.

W. Va., St. Marys—R. W. Russell is in the market for two 40 hp. type N Fairbanks-Morse and one 300 to 350 hp. gas engine with 200 kw., 2,300 volt, 3 phase, 60 cycle alternator.

Wis., Elcho — The Eastern Wisconsin Electric Co., 428 North 8th St., Sheboygan, H. Ellis, Genl. Mgr., plans to build a power plant and dam, here. Estimated cost $50,000. Engineer not selected.

Wis., Janesville—The Janesville Milk Co., 24 North Bluff St., H. J. Casey, Mgr., is having plans prepared for remodeling milk plant, including new boilers, resetting old boilers, etc. Estimated cost $25,000. W. H. Blair, Janesville, Engr.

Wis., Janesville—Rock County, c/o J. A. Paul, Milton Junction, Chn. of Special Com., is receiving bids for the construction of a 2 story, 47 x 54 ft. and 20 x 25 ft. boiler house at the Insane Asylum, here. Estimated cost $30,000. R. Kaupert, 290 3rd St., Milwaukee, Engr. Noted Oct. 9.

Wis., Madison—F. Riley, Archt., Conklin Bldg., is receiving bids for the construction of a 2 story, 45 x 100 ft. boiler house, laundry and garage for the Madison Medical Assn., c/o R. S. Ingersoll, Lakeside St. Estimated cost $50,000. Noted Oct. 2.

Wis., Milwaukee — Mead & Seastone, Engrs., Journal Bldg., Madison, are receiving bids for structural steel, penstocks, tainter gates, etc., for power plant at Caldron Falls, for the Wisconsin Public Service Co., 559 Marshall St., here.

Wis., Milwaukee—The Public Museum, 814 Grand Ave., S. Barrett, Dir., is having plans prepared for one additional 250 kva. generating unit. Cahill & Douglas, 217 West Water St., Milwaukee, Engr.

Ont., Forest—The town is having plans prepared for the installation of a waterworks system, including 3 stage centrifugal pumps, c.i. mains, valves, hydrants, tower, etc. Test wells will probably be sunk this fall. Estimated cost $100,000. Chipman & Power, Mail Bldg., Toronto, Engrs. Noted Sept. 12, 1922.

Ont., Fort William—The Canada Steamship Co., Ltd., Victoria Sq., Montreal, Que., is in the market for coal handling equipment, here.

Ont., Swastika—The Twp. of Teck, M. Campbell, Kirkland Lake, Clk., is interested in prices on an electric lighting plant, here.

Ont., Toronto—The city, Toronto East Genl. Hospital Assn., City Hall, is having plans prepared for the construction of a 3 story, 400 bed hospital, including vacuum steam heating system with electrically driven mechanical ventilation, in the eastern part of the city. Estimated cost $500,000. It is probable that one wing will be built this fall at cost of $250,000. R. C. Harris, City Hall, Engr. W. Price, City Hall, Archt.

Que., Cap Rouge—The St. Regis Paper Co., Ltd., 70 St. Paul St., Quebec, plans to build a pulp mill and wharf, here, and will receive bids this month. Estimated cost $4,000,000. Engineer or architect not selected.

Que., St. Genevieve de Batiscan — The North Shore Power Co., Three Rivers, will receive bids about Nov. 15 for the construction of a dam at Chute de la Cheminee on the Batiscan River, to develop 4,000 hp., here. Estimated cost $500,000.

Australia, Melbourne — The State Electricity Comn. of Victoria, R. Liddelow, Secy., will receive bids until Dec. 15 for four 1,000 kva. single phase transformers and spares for the Morwell Power Scheme.

CONTRACTS AWARDED

Ark., North Little Rock (Little Rock P. O.)—F. Hines, Dir. of the United States Veterans' Bureau, 2306 Munitions Bldg., Wash., D. C., awarded the contract for additional buildings to United States Veterans' Hospital 78, here, to Murch Bros., Ry. Exch. Bldg., St. Louis, Mo., $618,909. Noted Sept. 25.

Idaho, Lewiston—The city awarded the contract for complete waterworks improvements, including c.i. pipe line, two reservoirs and filtration plant, to the Chanute Constr. Co., Chanute, Kan. Estimated cost $346,000. Noted Sept. 25.

Ind., South Bend—The city awarded the contract for the construction of a pumping station to the Hay-Wever Co., South Bend, $157,400; suction well to Phelps & Son, Knoxville, $27,000; chimney to H. R. Heinecke, 540 North Meridian St., Indianapolis, $6,083; pumps to the Allis-Chalmers Co., 1410 Waldheim Bldg., Kansas City, Mo., $69,900; boilers to the Union Iron Wks., Lackawanna Siding, Hoboken, N. J., $23,008; coal and ash handling equipment to the Link Belt Co., 910 South Michigan Ave., Chicago, $12,143. Noted Oct. 16.

Mich., Lansing—The Herndon Fruit Co. awarded the contract for the construction of a 4 story, 84 x 280 ft. cold storage house to C. Ewing, Lansing.

Mo., St. Louis—The Franciscan Sisters, St. Anthony's Hospital, Grand Blvd. and Chippewa St., awarded the general contract for the construction of a 5 story, 50 x 135 ft. hospital to J. J. Grewe, Century Bldg., St. Louis. Estimated cost $250,000. Equipment detail not reported.

N. Y., New York—M. Gerschlesser, c/o Rouse & Goldstone, Engrs. and Archts., 512 5th Ave., will build a 15 story hotel on West 44th St. by separate contracts under supervision of architects. Estimated cost $1,250,000. Equipment detail not reported.

N. Y., New York — The Seventy Four West 68th St. Corp., c/o R. L. Lyons, Engr. and Archt., 342 Madison Ave., will build a 10 story apartment house at 72 West 68th St. by day labor. Estimated cost $600,000. Equipment detail not reported.

N. C., Roanoke Rapids — The Roanoke Rapids Power Co. awarded the contract for the construction of a power station, enlarging the existing canal, altering present headworks and installing a 3,200 hp. waterwheel to operate under 30 ft. net head, direct connected by vertical shaft to 3,000 kva. generator to Stone & Webster, Inc., 147 Milk St., Boston, Mass.

Ohio, Cleveland—The Cleveland Ry. Co., Hanna Bldg., C. Stanley, Purch. Agt., awarded the contract for the construction of six 1 story, 40 x 43 ft. automatic substations at various points, to the Craig-Curtiss Co., 4614 Prospect Ave., Cleveland. Estimated cost $350,000. Noted May 29.

Ohio, Toledo — The Toledo Edison Co., Jefferson and Superior Sts., has authorized a $473,000 bond issue for extensions and improvements to plant. Engineer not announced.

Tenn., Jacksonville—The Dupont Fibre Silk Co., Dupont Bldg., Wilmington, Del., will build the first unit of $4,000,000 plant, here, by company forces. The owner will purchase equipment. Noted July 24.

Tenn., Memphis—The Peabody Hotel Co., Main and Monroe Sts., R. B. Snowden, Agent, awarded the contract for the construction of a 9 story department store on South Main and Monroe Sts., to the Gauger-Korsmo Constr. Co., 301 Endicott Bldg., St. Paul, Minn. Estimated cost $830,000. Elevators will be installed. B. Lowenstein Bros., Inc., Main and Court Sts., lessee. Noted Oct. 9.

Tex., Sweetwater—The city awarded the contract for the construction of a rapid sand filtration plant, 1,000,000 gal. filter, also pump, to R. C. Newcomb, 609 Scotland Bldg., Dallas, $38,150.

Wis., Fond du Lac—St. Agnes Hospital, 390 East Division St., awarded the contract for the construction of a 1 and 2 story, 57 x 128 ft. power house to the Hutter Constr. Co., 128 Western Ave., Fond du Lac. Estimated cost $150,000. Noted Oct. 16.

Wis., Neenah—E. Defnet, Secy., 159 East Forest Ave., awarded the contract for the construction of a 1 story, 50 x 80 ft. cold storage plant to A. Nielson & Son, 702 South Commercial St., Neenah. Estimated cost $40,000. The owner is in the market for cooling and refrigeration machinery.

Wis., Wausau—The Underwood Veneer Co. is building an 8 ft. single band sawmill, operated with a 300 hp. steam generating plant. Later a planing mill will be built and equipped.